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Big data utilization and its effects on the controller role

Master's thesis

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Abstract

The term big data is fairly new, but seems to be applied in almost every area of human activity at the moment. The reason for this popularity is the exponentially growing amount of information made available by developments in computing and telecommunications technology, particularly the internet and auditing domains.

The purpose of the thesis is to investigate how companies utilize Big data in their operations and how it has been effected to controllers' roles. One examination object in this study is also strategic decision making and controller role in this process. The literature review looks at how researches describe the decision making process, and how they see controller role in it.

This thesis based on a qualitative case study and the purpose is to interpret from the case companies collected data from a theoretic perspective. In addition to the literature review, the question is studied in three machine engineering companies by interviewing experts. Machine engineering companies use a lot of data at different stages of the production and supply chain. For this reason, it was topical to include this field as case companies to this study. The empirical part includes eight semi-structured interviews from these companies.

The results of the study show that the utilization of big data is still in the early stages of companies, so it has not yet significantly influenced the controller role. However, the utilization of big data is considered very important and companies are working to develop it. Utilizing Big data is believed to have an impact on the controller's role in reducing manual work and providing more up-to-date and comprehensive information smoother and faster. Big data is believed to allow faster access to information, leaving more time for analysis and action development. Controllers tend to be more than just data producers in the decision making process. They are perceived to support management in decision-making, although final decisions are made by company management.

Keywords: controller, management accountant, big data, strategic decision making

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Tiivistelmä

Big data on terminä melko uusi, mutta sitä tunnutaan sovellettavan tällä hetkellä melkein kaikilla liiketoiminnan aloilla. Syynä tähän suosioon on tietojenkäsittelyn eksponentiaalisesti kasvava määrä, mikä on seurausta laskenta- ja tietoliikennetekniikan kehityksestä.

Tämän tutkielman tarkoituksena on selvittää, kuinka yritykset hyödyntävät big dataa toiminnassaan ja miten se vaikuttaa controllerin rooliin. Tutkimuksen kohteena on myös strateginen päätöksenteko ja controllerin rooli päätöksentekoprosessissa. Kirjallisuuskatsauksessa tarkastellaan, miten tutkijat ovat kuvailleet päätöksentekoprosessia ja kuinka he ovat nähneet controllerin roolin siinä.

Opinnäytetyö perustuu kvalitatiiviseen tapaustutkimukseen ja tarkoituksena on tulkita case-yrityksistä kerättyjä tietoja teoreettisesta näkökulmasta. Kirjallisuusosan lisäksi kysymystä tutkitaan kolmessa konepajayrityksessä haastattelemalla asiantuntijoita. Konepajayritykset käyttävät paljon erilaista tietoa tuotanto- ja toimitusketjun eri vaiheissa, joten oli mielenkiintoista sisällyttää tämän alan yritykset tutkimukseen. Empiirinen osa sisältää kahdeksan puolistrukturoitua haastattelua case-yrityksistä.

Tutkimuksen tulokset osoittavat, että big datan hyödyntäminen on edelleen alkuvaiheessa yrityksissä, joten se ei ole vielä vaikuttanut merkittävästi controllerin rooliin. Big datan hyödyntämistä pidetään kuitenkin erittäin tärkeänä ja yritykset työskentelevät sen kehittämisen eteen. Big datan hyödyntämisen uskotaan vaikuttavan controllerin rooliin tulevaisuudessa siten, että se vähentää manuaalista työtä sekä tarjoaa ajantasaisempaa ja kattavampaa tietoa sujuvammin ja nopeammin. Big datan uskotaan mahdollistavan nopeamman tiedonsaannin, jolloin controllerille jää enemmän aikaa analysointiin ja toiminnan kehittämiseen. Controllerien koetaan olevan päätöksentekoprosessissa enemmän kuin vain tietojen tuottajia. He ovat johdon tukena päätöksentekoprosessissa, vaikkakin lopulliset päätökset tekee yrityksen johto.

Avainsanat: controller, talousjohtaminen, big data, strateginen päätöksenteko

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1 Introduction

1.1 Backround of the study

Big data and its benefits are widely talked about these days, and companies have begun exploring ways to utilize it. The term big data is fairly new, but seems to be applied in almost every area of human activity at the moment. The reason for this popularity is the exponentially growing amount of information made available by developments in computing and telecommunications technology, particularly the internet and auditing domains. (Vasarhelyi et al., 2015).

The purpose of the study is to investigate how companies utilize Big data in their operations and how it has been effected to controllers' roles and decision making processes. The role of the controller in the organization has changed over the past decades. Many firms have been experience significant change in their organizational designs, competitive environments and information technologies (Burns and Vaivio, 2001).

One big reason of the role change is the development of technology, which is reduced controller's manual works, and new analytics systems make possible faster and deeper accounting information creating (Bhimani, 2013).

Some authors have suggested that long-standing beancounter stereotype is disappearing, but according Friedman and Lyne (2001) it is rather multifaceted. They said that beancounter is seen traditionally with precision and form, methodical and conservative, but they found in their research that nowadays it is incorporating several very different nuances.

This study examines what different kinds of roles and dimensions the controller has had and still has, and the views and conclusions of different researchers on how roles have changed. The study also explores the reasons for the role change, i.e. the things that have contributed to it.

Pickard and Cokins (2015) explain data mining and analysis (DM&A) methods and tools have improved, which have almost eliminated the learning curve applying DM&A techniques and models. Same time the need for these kinds of methods have increased. This change affects the roles of accountants and finance professionals. The role can be more strategic, future oriented and proactive in organization (Pickard & Cokins, 2015).

One examination object in this study is strategic decision making and controller role in this process. In this part will be studied that how authors has descripted the decision making process, and how they have seen controller role in it. Many authors have argued that management accountant have evolved into members of the management team and they are seen as willing and capable to provide more added value to the decision making and control (Goretzki, Strauss & Weber, 2013).

According Goretzki et al. (2013) managements accountans are 'business partners' and they are seen as willing and capable to provide more added value to the desicion-making and control. This change based on management accounting culture modification in the organizations. Gamble (1999) mentions in his study that creating an environment in which effective strategic decision making can take place is vital to corporate survival (Child and Keiser, 1981).

The scope of this study is limited to management account and the role of controllers. Both the literature review and the empirical part focuses on opportunities and challenges of using big data and how big data affects the role of the controller. The study does not discuss the technical side of big data, nor the big data analysis or business intelligence.

This study is based on a qualitative case study. The aim is to obtain a theoretically substantiated interpretation of the research objects. Target is to get a good understanding of the current situation in the case companies, therefore the main empirical method was the interviews that were conducted in controllers and experts working on big data.

1.2 Objectives and research questions

The study examines the current state of utilizing big data. In addition to the literature review, the question is studied in some of the machine engineering companies by interviewing experts. Machine engineering companies use a lot of data at different stages of the production and supply chain. For this reason, it was interesting to include engineering companies as case companies to this study. Utilizing big data can bring significant benefits, both operational and financial, and one of the purpose is find out how big data is utilized in companies and what kind of plans have been made for it.

The study is conducted from a financial management perspective and therefore focuses specifically on the question of how the use of big data affects the role of controllers.
The purpose is to investigate the situation, where the different engineering companies are in the process of implementing Big data, how the changes have affected or will affect the role of the controller and what is the controllers' role in decision making processes. All these questions will be study from the literature point of view, and via the case companies.

The main research question is:

- How Big data utilization affects the controller's role

The main research question is heavily influenced by what kind of action plans the organization has made for big data, what the current situation is, and what kind of timeline is in progress. For this reason, the question of how big data is used in business will also be explored. The study examines the role of the controller, and decision-making process is one part of the role. Is controllers' role to produce information to support decision-making or to participate in the actual decision-making process? Therefore, the study will als explore, what is the role of the controller in the decision-making process.

The study also explores the following issues:

- How Big data is used in businesses
- What is the controller's role in the decision making processes

1.3 Limitations and method

The scope of this study is limited to management account and the role of controllers. Both the literature review and the empirical part focuses on opportunities and challenges of using big data and how big data affects the role of the controller. The study does not discuss the technical side of big data, nor the big data analysis or business intelligence.

This study is based on a qualitative case study. The goal is to provide a theoretically informed interpretation of field data. Target is to get a comprehensive understanding of the current situation in the case companies, consequently the main empirical method was the interviews that were conducted with controllers and experts working on big data. The interview questions for the controllers were the same regardless of which company they worked for of these three case companies. Instead, for experts who works with big data, was asked questions on the same subject, but they were formulated to suit the task. Both question frames can be found in the remainder of this study, in the appendices. Interviews were a comprehensive way of gathering information about the current situation and the views of the interviewees.

The literature review serves as a basis for empirical research and provides a theoretical footing for the results obtained and thus helps to evaluate the results. The empirical part of this study corresponds to the topics of the theoretical part in order to obtain a clear overall picture and also to see the differences.

According to Saunders et al. (2009) it is important to evaluate the credibility of the research results in terms of reliability, repeatability, accuracy and generalizability. The results will be as reliable and successful as possible if the research is carefully planned. The results of the study are evaluated on the basis of these criteria at the end of the study in section six.

1.4 Structure of the thesis

The thesis consists of six main chapters, which are divided into a theoretical part and an empirical part. The first chapter explains the purpose of the study, the research questions and the subjects. There are also presented the limitations and method. The second chapter reviews the main content of the study as a literature review. The third chapter discusses methodology both in general and in the context of this study.

Empirical part includes case study, discussion and conclusion. The fourth chapter explains the thesis' empirical case study. This section reviews the responses from the expert interviewees. The answers to the interviews are divided in this chapter according to the topics of the interview frame. The topics of the empirical case chapter correspond to the topics of the theoretical chapter both in content and order. The chapters five and six contain the analysis and summary.

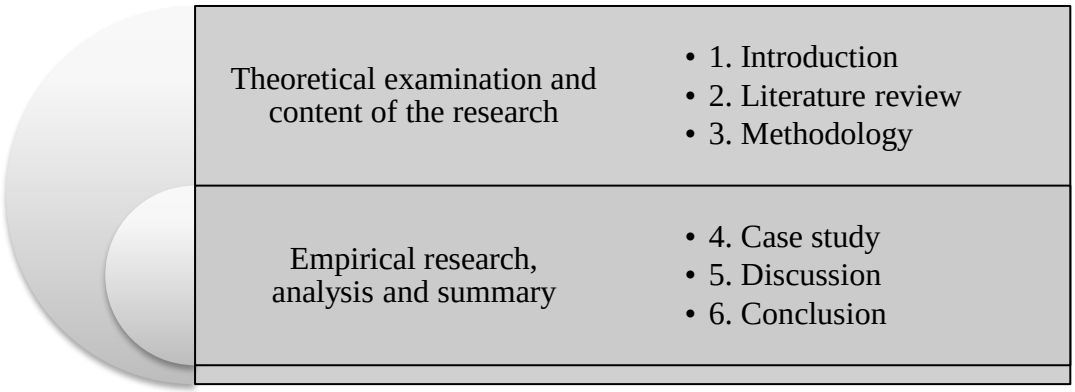

Figure 1. Structure of the thesis.

2 Literature review

This chapter presents the theoretical backround for this thesis. The theoretical backround based on a literature review of research topics and questions that are important to the thesis. This chapter discusses various management accounting roles in more detail.
It also examines what has been discussed in relation to role changes, the reasons for them and how the role changes. Addition, it examines the decision-making process and the role of controller in the process.

2.1 Different management accountants roles

There are many researches about the different controller roles. In literature, the traditional role of financial management is described by the term beancounter. Some authors have suggested that long-standing beancounter stereotype is disappearing, but according Friedman and Lyne (2001) it is rather multifaceted. They said that beancounter is seen traditionally with precision and form, methodical and conservative, but they found in their research that nowadays it is incorporating several very different nuances.

De Loo et all (2011) mentioned the debate around the topic. Some researchers see management accounting profession and roles are changing from beancounter stereotype to business advocate. Business advocate supports and advise senior managers in strategic decision making. Some researchers argue more static view about the roles and sees that bean counter stereotype exists, especially in smaller sized firms. There also is argued hybrid management accountants, who are both involved in bean counting and business advocate type of activities.

Also Caicedo, Mårtensson & Tamm Hallström (2017) stated, that the role of management accounting has been developed, so that it is widened from focusing on operational issues to a wider scope of responsibility that includes participation in decision-making. In other words, from being a provider of information or ‘bean counter” to a supporter of management in its

decision making as a 'business partner'. Caicedo et al (2017) also argue that the development of the role of the management accounting should conceptually include also contraction and de-hybridization, not only expansion and hybridization.

De Loo et al. (2011) investigated how the roles of management accountants had changed during 2004-2007 in Netherlands. They selected to analyse activities and how these evolved with the time span. Authors saw that there is not clear transition from bean-counter to business-oriented accountant. Authors argued that there is still much traditional work done by management accountants. They mention that changes are occurring, but there may be possible hybridization of the management accountant profession in The Netherlands. Also, authors do not believe that only business-oriented management accountants will be needed in the future and there is a space for different types of management accountants.

Granlund and Lukka (1998 b) discuss the management accounting practices' change. Their aim is to illustrate that there are clear signs of the global homogenization of management accounting practices also in a rather unique national culture. Authors use the macro level approach and identify three pressure categories. These are economic-, coercive- and normative pressures. Coercive pressures reflect the enforcing regulative aspects of certain institutions. Normative pressures reflect the social aspects in human behaviour. Such as values, norms and roles are in this category. Authors explain that there is drives of divergence, but in the macro level drives of convergence are greater than those of divergence. They mention the most prominent drivers of convergence, such as intensified global competition, the application of advanced information systems and software packages, the increasing significance of transnational institutions, the global consultancy industry and the use of globally applied textbooks in teaching.

Authors mention that national and corporate cultures or institutions are limiting the development of homogenization, but the same time these are losing their influence due to the intensified internationalization of business communications and operations. Also, authors explain that they do not think that impact of national cultures in management accounting practices have entirely vanished, but they see their impact in the micro level and their role is currently diminishing.

Byrne and Pierce (2007) developed a model where antecedents and characteristics of individuals and activities affected on the roles of management accountants. Authors mention that management accountants themselves have a considerable influence on the design of their own roles. Accountants' attitudes, personalities and initiative were important issues on this development. Business knowledge, interpersonal and communication skills were important characteristics according to the study. Therefore, accountants require strength of character. Considering this, authors argued that perhaps not all accountants can move towards hybrid roles. De Loo et all (2011) also mentioned person-related factors and these significantly affecting on the roles. Besides personal characteristics Byrne and Pierce (2007) mentioned that company affects on the roles too. Company's size and is it subsidiary or independently owned affects the roles.

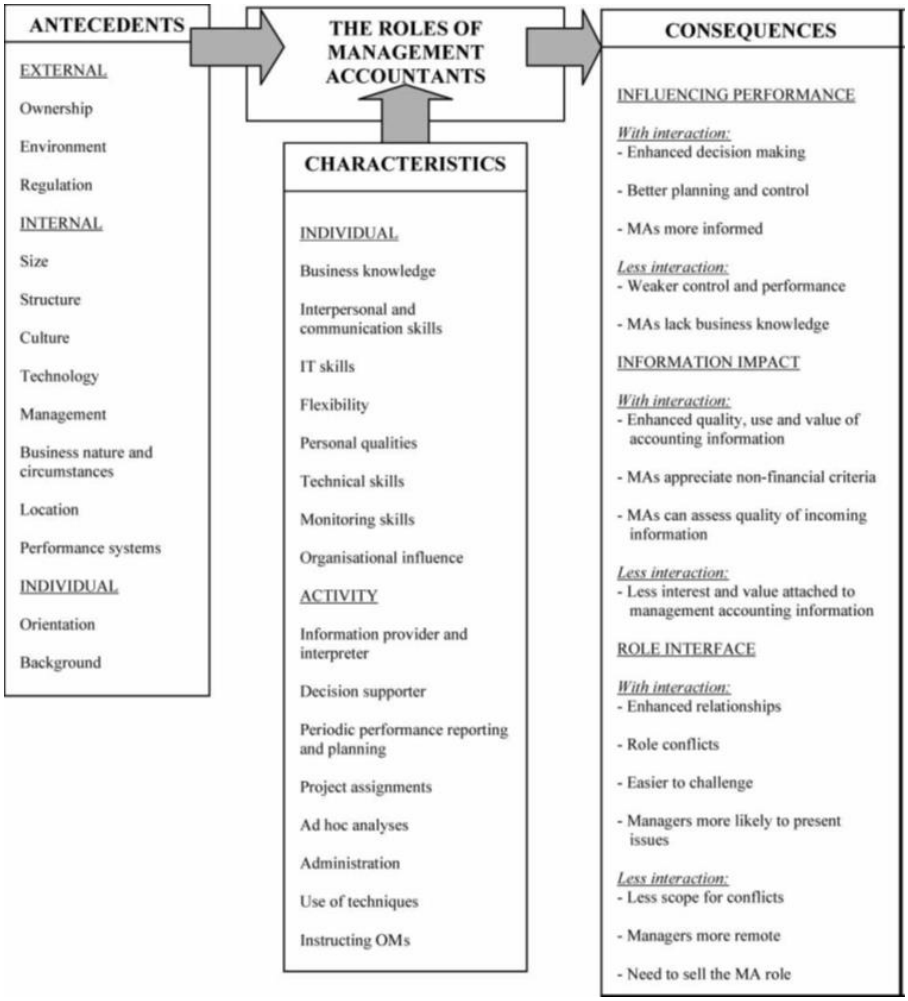

Figure 2. Antecedents, characteristics and consequences associated with the roles of Management accountants. (Byrne & Pierce, 2007).

Also, according Grandlund and Lukka (1998) there is a need for management accountants to move away from the roles of business historians and company watchdogs towards more commercially oriented functioning. In the new role, management accountants operate like true members of management teams and are able to act as change agents in organizations (Figure 3). Grandlund and Lukka (1998) said that it is important to understand that the figure 3 is concerned with the additional parts of the management accountant's role. This means that the upper roles including new and wider dimensions in the job description. The lower levels, general historiography of the role and 'watching over' are the basis for accounting regardless of how other roles have been built into them.

Figure 3. The expansion of the management accountant's job description (Granlund & Lukka, 1998)

Graham (2009) has investigated that management accounting role had moved from the old-fashioned 'corporate cop' into the business partner whose job is to add value to the business and they should be the part of management team, where they can support strategy and drive change. Author argue that employers also want them to police the management and act as the corporate conscience, therefore these separate tasks also bring very different kind of tensions to the role. Graham presented the dimensions of the management accountant role (Figure 4).

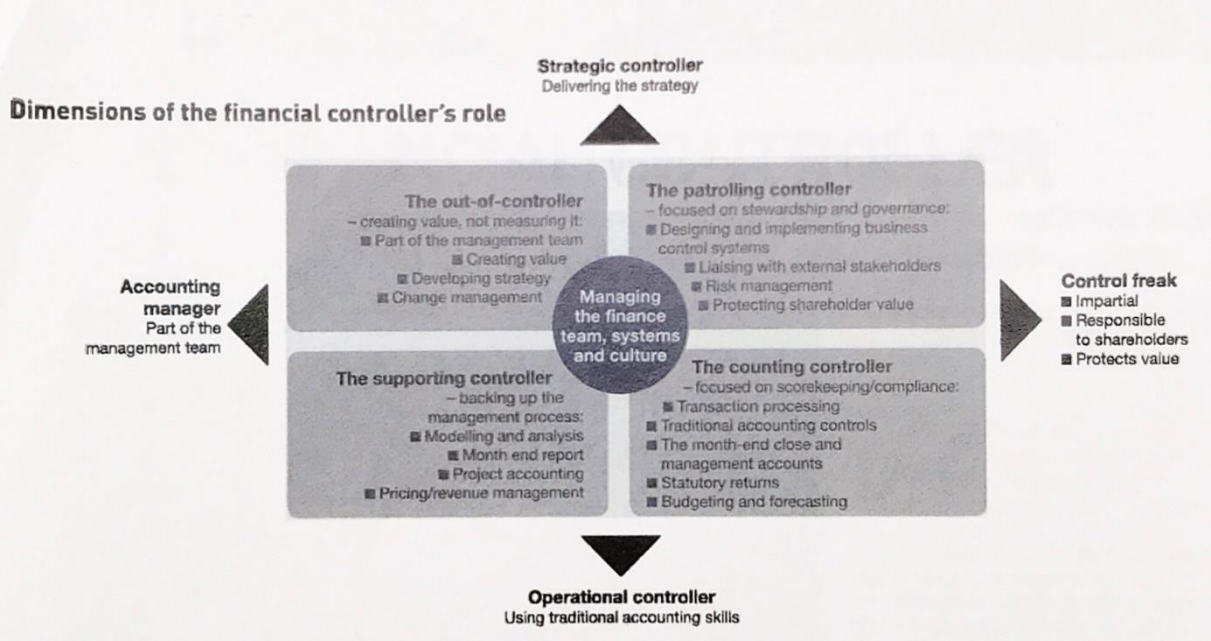

Figure 4. Dimensions of the financial controller's role (Graham, 2009).

Sathe (1983) has created role categories for controllers. This category is widely used as baseline in present studies in controller role. Authors idea is to provide management with a way of thinking about the role and what kind of role could suit for the organization.

Reality, controllers do not fall into one of the four ideal types.

Sathe describes **the involved controller** as responsible for management-service. This type is actively involved in the business decision-making process. Benefit for this is that active involvement helps management consider financial analysis and get controllers expertise proactively.

The independent controller's main emphasis is financial reporting and internal control responsibilities. This type of controller retains objectivity and independence in dealing with management. Benefit is more assurance concerning the accuracy of financial reporting and integrity of internal control. However, independent controller can be seen as outsider of the

organization or even as a corporate spy. This can complicate controller's ability to get sensitive information.

The split controller is that kind of arrangement where financial-reporting and management-service responsibilities are assigned to different individuals.

The strong controller remains both major controller responsibilities. Controller is actively involved in decision making process and retain sense of objectivity and independence. This type demands greater interpersonal and other skills to make controller to succeed in his/her work.

2.1.1 Management accounting and organisation culture

There have been a lot of conversations about the changes in management accounting role in the literature. This has been the interested topic especially during the last decades. According Burns and Vaivio (2001), there have been extremely challenging times for management accounting, both academics and its practitioners. They mentioned that many firms have been experiencing significant change in their organizational designs, competitive environments and information technologies.

Järvenpää (2007) stated in his study that it would be important to understand the core meaning of organizational culture that can realize management accounting culture and changes in it. Organizational culture appears in many different ways, therefore it is not unambiguous concept. Often organization culture is divided into hierarchical levels and includes e.g. global, international, multinational, national and regional parts, and as well different operational levels like corporate, department, functional and group cultures. Culture consists of many different things, and according Edgar Schein (1987) it includes visible structures, functional phenomena, human creatures (artifacts), values and norms and basic assumptions.

There are also different subcultures within organizations. Järvenpää (2007) gives an example, different professional groups have different view of the world and the nature of their business. Accountant might follow to one kind of philosophy and marketing people to another. Every group might have their own language and assumed culture.

Granlund and Lukka (1998) mentioned other traditional organization setting, which is that Finnish management accounting function have cooperation more with production people than marketing and sales people. At the present time there are clear signals that accounting management is moving from the inner processes to the outside environment of firms. This means that the cooperation between accountants and sales people will increases and be more strengthen in the future.

Järvenpää (2007) discovered during his study that accounting is a cultural phenomenon that is inherently deeply embedded in the organization. The most important tools which moving towards the direction of business orientation structural interventions are effective accounting system development, the new accounting innovations which support business management, human resources management, the directing of personal attention, and the role modelling performed by top management and financial management, official value statements, and, furthermore, storytelling related the change and top controllers. According to Järvenpää, the new managerial values and expectations influenced accountants in close day-to-day cross-functional cooperation. Decentralized accountants strongly sensed the need for business support in the units they served (Järvenpää, 2007).

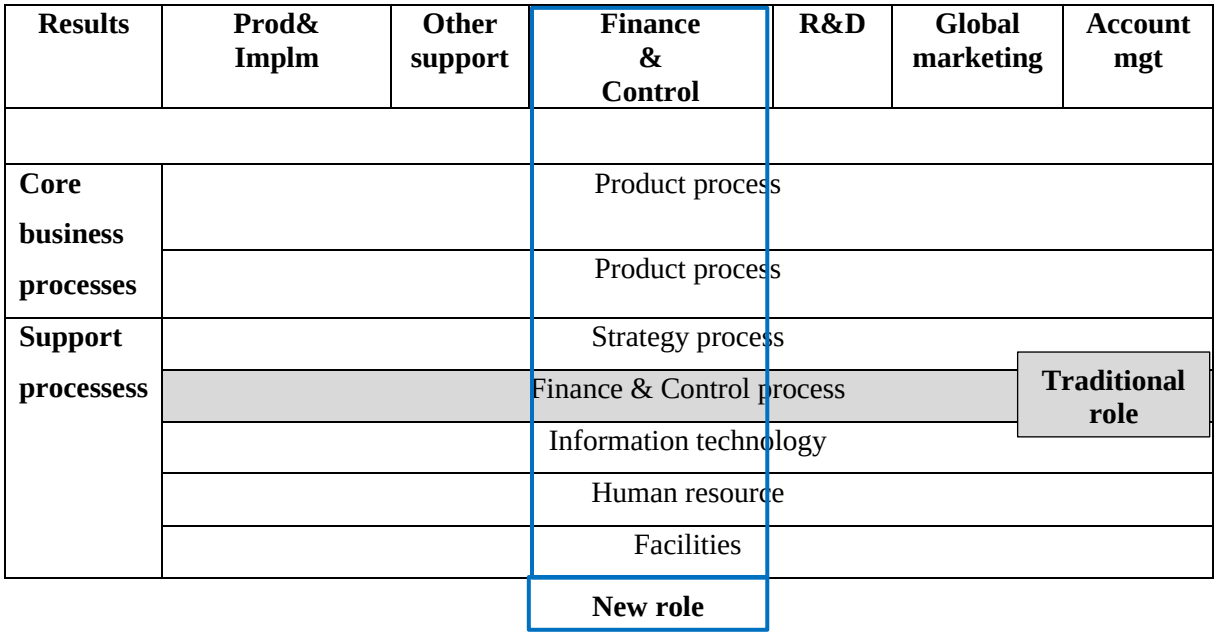

Figure 5. The new role of finance and control (Järvenpää 2007, internal training material 1995)

Granlund and Lukka (1998 b) discuss the management accounting practices' change. Their aim is to illustrate that there are clear signs of the global homogenization of management accounting practices also in a rather unique national culture. Authors use the macro level approach and identify three pressure categories. These are economic-, coercive- and normative pressures. Coercive pressures reflect the enforcing regulative aspects of certain institutions. Normative pressures reflect the social aspects in human behaviour. Such as values, norms and roles are in this category. Authors explain that there is drives of divergence, but in the macro level drives of convergence are greater than those of divergence. They mention the most prominent drivers of convergence, such as intensified global competition, the application of advanced information systems and software packages, the increasing significance of transnational institutions, the global consultancy industry and the use of globally applied textbooks in teaching.

Authors mention that national and corporate cultures or institutions are limiting the development of homogenization, but the same time these are losing their influence due to the intensified internationalization of business communications and operations. Also, authors explain that they do not think that impact of national cultures in management accounting practices have entirely vanished, but they see their impact in the micro level and their role is currently diminishing.

2.1.2 Reasons for the role changes

Reasons for management accounting change and new roles of accountants is wide. Pickard and Cokins (2015) explain data mining and analysis (DM&A) methods and tools have improved, which have almost eliminated the learning curve applying DM&A techniques and models. Same time the need for these kinds of methods have increased. This change affects the roles of accountants and finance professionals. The role can be more strategic, future oriented and proactive in organization (Pickard & Cokins, 2015). Also, the implementation of modern financial and operational control systems and software packages, such as ERP systems, have helped to carry out routine activities more effectively (Järvenpää, 2007).

Burns and Baldvinsdottir (2007) list key drivers for change: changing business market conditions, organisational re-design, new managerial philosophies, increased business complexity, systems development, management technique innovations, human resource developments, champions of change and myths about the benefits of change. Authors use institutional theory to understand the change (Burns & Baldvinsdottir, 2007).

Seo and Creed (2002) have combined four propositions regarding the nature of institutional change. First, the presence and degree of misaligned interests increase possible change agents. Second, weak non-adaptability, efficiency gaps and interinstitutional incompatibility increase praxis for institutional change. Third, strong non-adaptability, efficiency gaps and interinstitutional incompatibility mediated by institutional crisis enhance praxis for change.

Fourth, the degree and number of interinstitutional incompatibilities increase the likelihood of praxis for institutional change by increasing the number of frames and logics available (Seo and Creed, 2002).

Researchers have also investigated how cultural context affect management change (Järvenpää, 2007 and Granlund & Lukka, 1998). Järvenpää (2017) found that the increasing business orientation of accounting affected also different cultural change interventions. These interventions were formal, such as training or official value changes, or informal and same time unconscious by nature, such as storytelling or role modelling. Granlund and Lukka (1998) noticed general cultural transition in Finnish society. They study the impact of Finnishism on financial management practices. According to them, financial management practices are tied to the surrounding national culture. Finnishism and the Finnish financial management culture are currently undergoing a significant transition. Internationalization being one key element. The most significant change is that controllers are becoming important factors in the organization's decision-making.

2.1.3 Strategic decision making

Dent (1990) explores strategy and decision-making process theory. Author mentions strategy as elusive concept and term has used a variety of disciplinary literatures. There has not one simple definition for it. Still Dent argues that there is a common theme. Strategy constitute a logic underlying an organization’s interactions with its environment. This in turn guides its deployment of resources.

Author also explains different themes how strategy can be study. Researchers in different disciplinary backgrounds have different interests in strategy. One research stream focus on link between strategy and structure. Another stream is interested of analysing different strategies in specific competitive environments. Third stream focusing on the complex processes through which strategies emerge in organizations.

Also, Vaivio (2007) mentions in his study that decision making processes are rarely rational and linear and they involve many actors who represent diverse opinions, interest, biases hidden agendas and competencies. Vaivio says that decision making processes often gets interrupted, marginalized, diverted, restarted or merged with another stream of urgent concerns.

However, Dent points out that strategic reorientation happens rarely and usually strategic decision making constitutes an elaboration or refinement of existing strategies. For example, Mintzberg (1978) argues that strategies unfold in long overarching life cycles, with phases of conception, elaboration, decay and death. But the tendency is towards continuity and elaboration.

Amason (1996) focusing on the quality of the decisions and he identify two principal antecedents of decision quality: the cognitive capabilities of a top management team and the interaction process through which the team produces its decisions. He mentions that Bantel and Jackson (1989) and Murray (1989) has found that the top management teams with diverse capabilities make more innovative and higher-quality decisions than in the unilateral teams. The higher quality seems to be realised easier if there are critical and investigative interaction processes where team members identify, extract and synthesize their views of the decisions. Many authors argue that decision-making processes where decisions are made with consensus between team members improve organizational performance more than decision processes that do not promote consensus. Also, affective relationships are important. This allow team members to work together effectively (Amason 1996).

Sathe (1983) explains to think management and organization, when deciding controller's involvement in decision making process. What kind of benefits this individual can give to the process? Also, managements' expertise should consider.

According to Goretzki, Strauss & Weber (2013), many authors have argued that management accountant have evolved into members of the management team. The management accountans are 'business partners' and they are seen as willing and capable to provide more added value to the decision-making and control. This change based on management accounting culture modification in the organizations. Gamble (1999) mentions in his study that creating an environment in which effective strategic decision making can take place is vital to corporate survival (Child and Keiser, 1981).

Neumann (2016) argues that individual emotions are essential driving forces in strategic decision making. According to Neumann some researches have found that positive emotions lead to better, more efficient decision making because of more careful and systematic processing (e.g. Isen 2001), while others have concluded that negative emotions lead to more effortful processing (e.g. Forgas and George 2001). Neumann mentions Hodgkinson and Hayley's (2011), who say that emotions and cognition interact and have a combined effect in the strategic decision making context. In this context, two theory streams on the interaction between emotions and cognition have emerged; the first one more strongly addresses the influence of cognition on emotions (e.g. Lazarus 1966), while the latter assumes that emotions affect cognition.

Nielsen et al. (2014) have studied management accounting and decision making process from the outsourcing decision point of view in two substantial manufacturing companies. These two case studies reveal two different methodological approaches to decision making: analytical and actor-based. According to Nielsen et al. (2014) the core disagreement between these two views is whether accounting information can be produced to sufficiently describe and calculate the consequences of alternatives in a complex practical context, or whether it can fit into an organic process in which decision making is more qualitative. The analysis in this study shows that accounting can indeed be produced and used in relation to complex strategic decision situations, and also that the forms and roles that management accounting takes in practice can be different, dynamic and complex.

2.2 Big data

The term big data is fairly new, but seems to be applied in almost every area of human activity at the moment. The reason for this popularity is the exponentially growing amount of information made available by developments in computing and telecommunications technology, particularly the internet and auditing domains. There does not have a shared and unambiguous definition to the term big data, and it is usually used assuming that the reader understands its meaning at the intuitive level. (Vasarhelyi et al, 2015). According Ministry of transport and communication in Finland (LVM, 2014) it is often used a definition that includes three V, which refers to words volume, velocity and variety.

Al-Htaybat and Alberti-Alhtaybat (2017) note that the digital revolution in the past few decades had led to the 'persative phenomenon of Big data' (Moffitt and Vasarhelyi, 2013, p. 2), which has caused quite a hype in recent years. They told that 'Data is the new oil" is one of the popular catchphrases; even 90 % of the world's data has been created since 2010 is a frequently menitoned fact, and in general the belief is that big data poses a great opportunity for organisations, governments and individuals to provide solutions to existing and future problems. (Al-Htaybat and Alberti-Alhtaybat, 2017)

According Ministry of transport and communication in Finland (LVM, 2014) there are following things that have been used in definitions: Amount (large amount of data to be used or stored), speed (data speed and real-time), diversity (the structure and location of the data varies and often requires a combination), technologies for processing, and the benefits of data analysis. Their report mentions that exploiting data has become a clear competitive advantage for business. More and more companies are adopting solutions based on data mass analysis that directly influence the operation of the company (LVM, 2014). Also Al-Htaybat and Alberti-Alhtaybat (2018) mentioned that Big data incoroporates more than extremely large data sets. The so-called "digital natives", the millennial generation, use the term "Big data" also to denote how information is harnessed in new ways (Jarivala, 2015).

Bhimani and Willcocks (2014) argue that organisations need to be sensitised to different types of knowledge, the challenges in creating and applying that knowledge, and be more circumspect about what can be achieved through advances in information-based technologies and software. They suggested that Big data and data analysis technigues enable executives to
act on structured and unstructured information, but such action must recognize that the traditionally presumed sequential and linear links among corporate strategy, firm structure and information systems design are no longer in play. Authors also mention that cost structure changes are affected by developments in how data, information and knowledge can be utilized. (Bhimani and Willcocks, 2014).

Manyika et al. (2011) defined big data as the next frontier for innovation, competition, and productivity (Intel IT Centre Peer Research, 2012). Addo-Tenkorang and Helo use five V´s model in their paper. There are velocity, variety and volume, but also veracity and value-adding components. Veracity refers to the function for analysing the big data and value-adding to the idea that using big data benefits the organization. Authors also describe these factors in s-curve model. This model illustrates the need to scrutinize the attributes of big data for a more optimum value-adding approach by squeezing a huge data volume (V3) for more enhanced data flow velocity (V2) into a lesser time and stepping up the data variety (V1) into a more enhanced date veracity (V4) in a lesser time (Addo-Tenkorang and Helo, 2016).

Ministry of transport and communication in Finland (LVM, 2014) claims in their report that the digital data storing and processing costs has fallen to a fraction of previous costs, because of technological development, especially cloud computing. According to them, utilizing big data there is visible benefits both in the business world and in public administration. These opportunities and benefits include, for instance operational optimization, and the savings it brings, getting more specific information to support decision making, getting more accurate picture of the situation, finding new models and connections through modeling, better customer service, and predicting the future. Increasing use of data based knowledge is becoming an absolute prerequisite for success. (LVM, 2014).

By analyzing data, one seeks a comprehensive understanding of phenomenon from which the data has been collected. After processing and analyzing the raw data, more refined information is created. The data utilizing value chain is illustrated in the following figure (figure 6). (LVM 2014, 8-9).

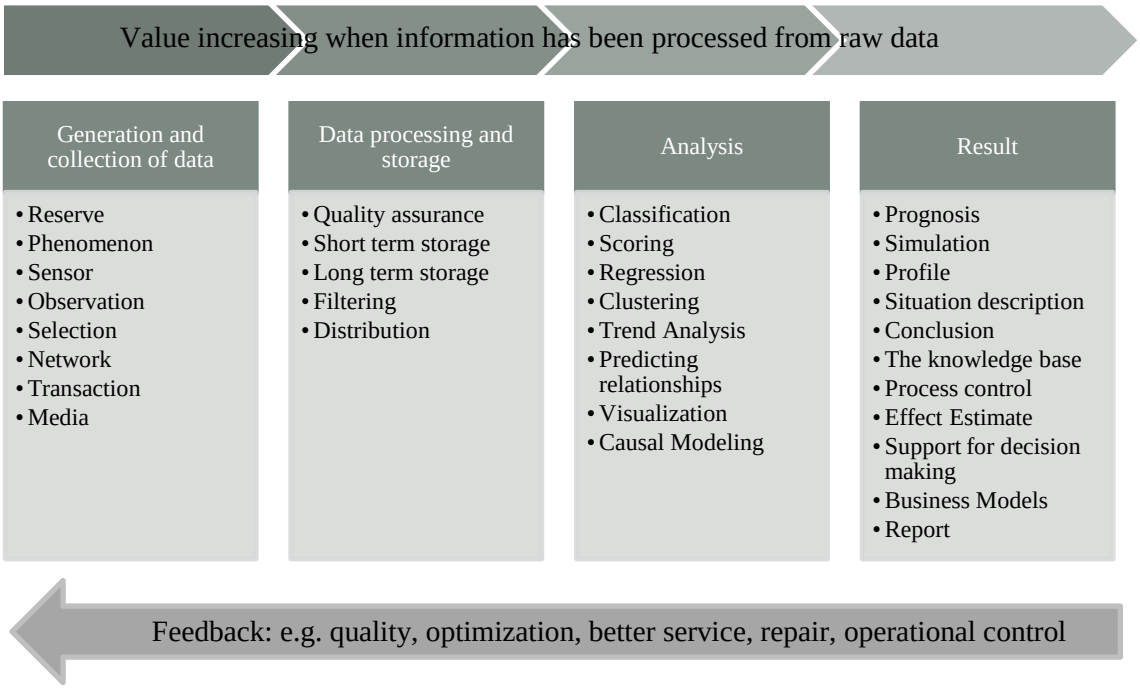

Figure 6. Value chain of data exploitation, according to the Ministry of Transport and Communications (LVM, Big data exploitation report, 20/2014)

The data value chain is not always as straightforward as what is illustrated in Figure 6, as new needs or services may arise at different stages and there may also be feedback between different stages. These may be related to data collection, quality assurance, processing or analysis. (LVM 2014, 9).

2.2.1 Big data and Accounting

Al-Htaybat and Alberti-Alhtaybat (2018) describe that Big data is an unrefined and raw resource that, in order to be useful, need to be refined, in other words, cleaned, structured and processed in order to generate any useful insight. Their broad question is what is the accountants' potential role and necessary skill set regarding Big data and corporate reporting. They also mentioned that Big data and accounting relationship is not regarded as unproblematic, and they were thinking what potential difficulties can be arised. One of their focus area in the study is technology related Big data and corporate reporting. Authors used term SoMoClo about social, mobile and cloud technologies and according them, these modern technologies encompass a broad range of technologies, related to web applications, new systems and software, which permeate all layers of organisations and society, and may be employed in an accounting context. These technologies matter in this context, because they are part of the "Big data creating" technologies. Cloud computing technology has emerged as a new information technology infrastructure and it enables ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources. (Al-Htaybat and Alberti-Alhtaybat , 2018).

Warren et al. (2015) argue that Big data will improve the quality and relevance of accounting information, which improves also transparency and stakeholder decision making.
According them, the video, audio, image and textual information made available via Big data can provide for improved managerial accounting, financial accounting, and financial reporting practices. Additionally, Big data can assist to ensure that the accounting profession will continue to provide useful information as the dynamic, real-time and global economy evolves. (Warren et al., 2015).

Warren et al. (2015) describe that Big data are large in size, therefore it cannot be analysed by traditional software and database system and are about 10 per cent structured and about 90 per cent unstructured. These unstructured data need further processing and analyzing before it can be utilized for reporting and decision making. Vasarhelyi et al. (2016) argue that Big data changes fundamentally what we mean by information, for example organisations have the ability to provide real-time information, which is contrary to traditional accounting of summary and aggregation of information provided on periodic basis. Warren et al. (2015) mention that Big data's utilisation in the context of internal control processes, creates a link between behavior and goals, which can lead to new performance measures.

Vasarhelyi et al. (2015) stated that a chronology of technology events can serve to explain the evolution of technology and accounting.

- Before computers, organizations retained only summary accounting data via the chart of accounts/general ledger
- Advances in computers made it possible to store and retain complete information about all transactions, thus leading to the first real issue of big data in accounting: what can be gained with access to an archive of every transaction conducted?
- Technology enabled businesses to become truly global, leading to a second expansion in the volume, velocity and variety of accounting data
- Enterprise systems, followed by the warehouse concept, integrated accounting data with data from nonfinancial systems leading to further expansion of the volume and variety of accounting data
- Further expansion of accounting data includes the addition of new types of data fields within specific accounting transaction records beyond what was traditionally recorded, many of which are obtained through automated sensors
- The automatic capture of data through sensors, and data streams allows for the definition of increased frequency of data capture and a large set of managerial, accounting, and assurance process expansions, as well as the addition of multiple sources of audit evidence (Vasarhelyi et al., 2015)

2.2.3 Challenges in using Big data

Big data also brings challenges and threats. They exist at the individual level, at the organizational level, and at the quality of the content and processing of the information.

In recent years, there has been much debate on privacy issues. A major step in protecting privacy was in May 2018, with the entry into application of the General Data Protection Regulation, there is one set of data protection rules for all companies operating in the EU, wherever they are based. Stronger rules on data protection mean that people have more control over their personal data and businesses benefit from a level playing field. The General Data Protection Regulation (GDPR) applies throughout the European Union and its purpose is to create a uniform and harmonised level for the protection of personal data so that the free movement of personal data within Europe is not hindered. (www.ec.europa.eu).

There are also threats to privacy and trust, concentration of data ownership on only a few players, excessive monitoring of users, and possible discrimination resulting from excessive profiling, such as disproportionate price increases for different fees based on the profile. (VLM 2014, 10)

At the organizational level, big data brings challenges to information security and trust. There are data protection risks involved in transferring huge masses of data. Not always is data transferable, which requires a third party to go directly to the analytics application and this presents a challenge of trust. In such cases, the organization will have to decide whether to trust the external application or the third party. Information security and trust are critical to the emergence of new information ecosystems. (VLM 2014, 11)

Poor quality, either in the content of the data or in the processing, is also a threat. This may be due, among other things, to errors or inexperience in the processing and analysis of large data sets. Also, the interpretation of the results may be misinterpreted or too weak. Irresponsible or incomprehensible use of Big data can lead to inaccurate data and may also result in incorrect data sorting. Big data processing emphasizes the importance of data interpretation, so it requires an understanding of statistical reasoning. (VLM 2014, 11).

2.3 Big data utilization and its effects on the controller role

Warren et al. (2015) states that the rising importance of big data will significantly impact accounting. This will be reflected in how data are accumulated and recorded, how management uses data to attain organization goals, and how reporting elements are processed and assembled. In 2000, about 25% of economic data was digitally stored, whereas today more than 98% is electronic. Big data provides an unprecedented opportunity for sophisticated, extensive data sets and sophisticated analytics. One of the important roles of accountants is to create systems that adapt organizational goals to the actions of management and employees. (Warren et al., 2015)

Bhimani and Willcocks (2014) mention in their study that Big data is increasingly becoming a core business asset. (Simons, 2013). The growth of big data together with increased processing power, sophisticated algorithms and advanced statistical methods suggest that there should be many opportunities to improve management reporting and understand the connections between financial and non-financial measures. (Hodginson and Gillon, 2012).

Big data offers the finance professional the possibility of moving into a more strategic, proactive role in business. (Chua, 2014). (Bhimani and Willcocks, 2014).

According Lamba and Singh (2017) the potential benefits of integrating big data analytics in operational supply chain management decision making clearly outweigh the investment and brings about a culture of competitive excellence across the organization (Terziovski, 2010).

Dedicated financial support from the top management can be highly imperative for the success of big data in supply chain management. (Lamba and Singh, 2017).

Brinch (2017) mentions in his study that from a business process perspective, big data and business analytics may create a new class of economic asset and help companies redefine their business and outperform their competitors (Fosso Wambe and Mishra, 2017). Existing literature tend to agree that big data can be defined with 3Vs: volume, variety and velocity. (Brinch, 2017).

The potential outcome of big data is, from a business process perspective, improved decision making quality, but this non-linear process varies depending the numerous data sources available (Janssen et al., 2017). Big data is related to business intelligence as well as business analytics and has emerged as a separate concept (Chen et al., 2012). According Brinch et al. literature agree that information flows are to support decision making through the process of data input, data processing and data output (Hazen et al., 2014), and this big data setting is associated to a knowledge-discovery process (Chen et al., 2014). (Brinch et al., 2012).

Warren et al. (2015) argue that big data can provide for improved managerial accounting, financial accounting and financial reporting practices. Big data will contribute to the development and evolution of effective management control systems and budgeting processes. Also, it will improve the quality and relevance accounting information, enchancing transparency and stakeholders decision making. From a reporting perspective, big data can assist with the creation and refinement of accounting standards. It also helps to ensure that the accountant provides useful information dynamically, in real time and global economy evolves. (Warren et al., 2015).

2.4 Theoretical summary

There are many researcher who see that management accounting roles are changing from beancounter stereotype to business advocate. According to the researchers, the role has developed to include, in addition to operational tasks, broader responsibilities as well as participation in decision-making. Some researchers stated that there is a need for management accountants to move away from the roles of business historians and company watchdogs towards more commercially oriented functioning. The expansion of the management accounting role is described in the literature section in Figure 3, page 9.

According to the literature person's individuality and mode of action affect the role of management accountant. In other words, they can themselves influence the development of the role with their attitudes, personality and initiative. Business knowledge, interpersonal and communication skills are important characteristics according to the literature. Antecedents, characteristics and consequences are associated with the roles of Management accountants. This This is shown in more detail in Figure 2, page 8.

The theoretical concept discussed the reason for change and there are mentioned the following factors: business market conditions, organisational re-design, new managerial philosophies, increased business complexity, systems development, management technique innovations, human resource developments, champions of change and myths about the benefits of change. According the researchers the most important tools in the transition to more business support structure are the efficient accounting systems development and new accounting innovations that support the functions of all organization. The cross-section of the various processes is illustrated in Figure 5, page 13.

Based on the literature accounting is a cultural phenomenon that is inherently deeply embedded in the organization. Organization culture is divided into hierarchical levels and includes e.g. global, international, multinational, national and regional parts, and as well different operational levels like corporate, department, functional and group cultures. Culture also includes visible structures, functional phenomena, human creatures, values and norms and basic assumptions.

Many authors have argued that management accountant have evolved into members of the management team. The management accountans are ‘business partners’ and they are seen as willing and capable to provide more added value to the desicion-making and control. This change based on management accounting culture modification in the organizations. According to the literature, decision making processes are rarely rational and linear. There can be involved many different actors representing different opinions, interests, biases hidden agendas and competencies. Accounting can be produced and used in relation to complex strategic decision situations. Also the forms and roles of management accounting takes in practice can be different, effective and complex.

Exponentially growing amount of information is the reason why Big data is topically important. This data made available by developments in computing and telecommunications technology, particularly the internet and auditing domains. Generally used definition to the term big data includes three V, which refers to words volume, velocity and variety. There are also five V´s model in use and it includes velocity, variety, volume, and veracity and value-adding components. Veracity refers to the function for analysing the big data and value-adding to the idea that using big data benefits the organization.

In the literature, also following things that have been used in the definitions: Amount (large amount of data to be used or stored), speed (data speed and real-time), diversity (the structure and location of the data varies and often requires a combination), technologies for processing, and the benefits of data analysis. Some studies defined big data as the next frontier for innovation, competition, and productivity. Big data is an unrefined and raw resource that, in order to be useful, need to be refined, i.e. cleaned, structured and processed in order to generate any useful insight. Big data will improve the quality and relevance of accounting information, which improves also transparency and stakeholder decision making. Big data can assist to ensure that the accounting profession will continue to provide useful information as the dynamic, real-time and global economy evolves.

Based on the theory Big data is large in size, therefore it cannot be analyzed with traditional software and database system. Also Big data is about 10 per cent structured and about 90 per cent unstructured. Big data provides an unprecedented opportunity for sophisticated, extensive data sets and sophisticated analytics. It also helps to ensure that the accountant provides useful information dynamically, in real time and global economy evolves. By analyzing data, one seeks a comprehensive understanding of the phenomena from which the data has been collected. After processing and analyzing the raw data, more refined information is created. The data utilizing value chain is illustrated in the Figure 6, page 20.

One of the important roles of accountants is to create systems that adapt organizational goals to the actions of management and employees. Big data changes fundamentally what we mean by information, for example organisations can have the ability to provide real-time information in the future, which is contrary to traditional accounting of summary and aggregation of information provided on periodic basis.

Some researchers stated that the growth of big data together with increased processing power, sophisticated algorithms and advanced statistical methods suggest that there should be many opportunities to improve management reporting and understand the connections between financial and non-financial measures.

3 Methodology

3.1 Case study as a research method

The purpose of the study was to investigate the utilization of Big data in various functions of the companies and its impact on the controllers' role and the decision-making process. The qualitative case study was chosen as the research method because the topic of the study is very multidimensional and relatively new to businesses. The aim of this qualitative case study is to gather information on how the theoretical interpretations of the subject under study are implemented in practice. Although big data is a new phenomenon, it can be expected to have affected the operation of the management account.

Quantitative research methods have been a popular research method for decades, but traditional surveys and numerical information are thought to provide only a superficial view of organizational practices. Therefore, more in-depth research methods have been sought. (Scapens 1990, 259).

According Vaivio (2008, 67) the qualitative research offers a deeper perspective about the subject of management accounting and because of this it serves an important educational and pedagogic purpose. Qualitative research aims to find theoretically valuable interpretations. The qualitative research is a messy and time-consuming affair and there are e.g. the following challences: identifying relevant theory, formulating the research objectives, gaining access, finding the key people, getting the hands on documents and being puzzled by conflicting interpretations. (Vaivio 2008, 64-65).

Vaivio (2008, 65) argues that the qualitative research on a management account is important for three reasons. First reason is the textbook view, which means that it provides a narrow and functional view of management accounting phenomenon. Second reason is the economic view, which means that the qualitative research protects us against a scientific imperialism that reduces management accounting to an issue of mere economic choice. Third reason is the consultancy view, that it critically scrutinizes normative prescriptions for improving management accounting.

The results in a qualitative individual case study are not generalizable, but they are intended to enrich the theoretical understanding of the topic and bring the theories into empirical reality. Such research can reveal the strengths and weaknesses of the theories and modify or disprove the theories. (Vaivio 2008, 77-79).

Case study is a suitable method when the subject of the investigation is considered in practice from a historical, economic, social or organizational context. Case studies provide us with an opportunity to understand the nature of the subject matter being investigated in practice, such as what techniques, procedures and systems are being used and how they are being used. (Scapens 1990, 264). There are different ways to use case studies. Descriptive case studies describes accounting systems, techniques and procedures currently used in practice. Illustrative case studies' purpose is to describe new and potentially innovative practices. Experimental case studies could be used to study the implementation of the new initiative and its challenges and to evaluate its benefits. Exploratory case studies can be used to explore reasons for particular accounting practices. Explanatory case studies attempt to explain the reasons for accounting practices. (Scapens 1990, 265).

This study is mainly illustrative case study, which purpose is to describe new and potentially innovative practices. The aim is to determine whether Big data has an impact on the controller's work in practice and role in decision-making. The topic of research is quite new phenomenon, which can be expected to change the procedures and way to work and it also can bring benefits to the businesses.

The study was conducted as semi-structured thematic interviews. The interviewees received the questions in advance and questions were conducted in the order in which they were drafted.

The interviews were conducted in the companies listed in the following table. The table also shows the roles of the interviewees and the business areas where they are working for. The interview questions were emailed to the interviewees about a week before the interview. All interviews were recorded to ensure that all questions and answers that came up can be saved.

Company	**Interviewees**
Valmet	Controller, Capital Business
	Controller, Mill Business
	Controller, Automation Business
	Director, Business Reporting Development
Metso	Manager, HFM application
	VP, Aggregates Business area
	Business partner, Customer logistics
Cargotec	Controller, Kalmar

3.2. Data collection and methodological decisions

The empirical interview study is based on a literature review. Saunders et al. (2009) have identified two important reasons why the literature review is an essential part of the thesis. The literature review is a tool for pre-research on a topic that can be used to form a research topic and research problem. Another reason is to lay the foundations for the findings and analysis.

When designing the structure of empirical research three main aspects of the research topic emerged: 1) the utilization of Big data 2) the role of the controller and the role changes and 3) the decision-making process. The questions can be found in the appendix to this thesis, but they are also briefly presented in the following sections.

Big data part of the research includes the questions how do companies understand Big data, how do they use it, or do they still use it, and how do they intend to use it in the future. In addition, the question was asked how important the interviewees perceive the utilization of Big data.

In relation to **the role of the controller**, the question was asked what are the controller's main tasks and goals, what kind of information the controller needs from different functions and what are the biggest challenges at work. Controllers were also asked how their role has changed with the use of Big data.

The decision making process asked whether the controller is involved in making decisions or rather generating information to support decision making. It was also asked what kind of information the controller needs to support decision-making and how the decision-making process could be improved.

Saunders et al. (2009) have described a summary of the research methodology using the onion pattern (Figure 7). The research bulletin presents six methodological themes at different levels. The themes used in this study are shown in bold in the figure.

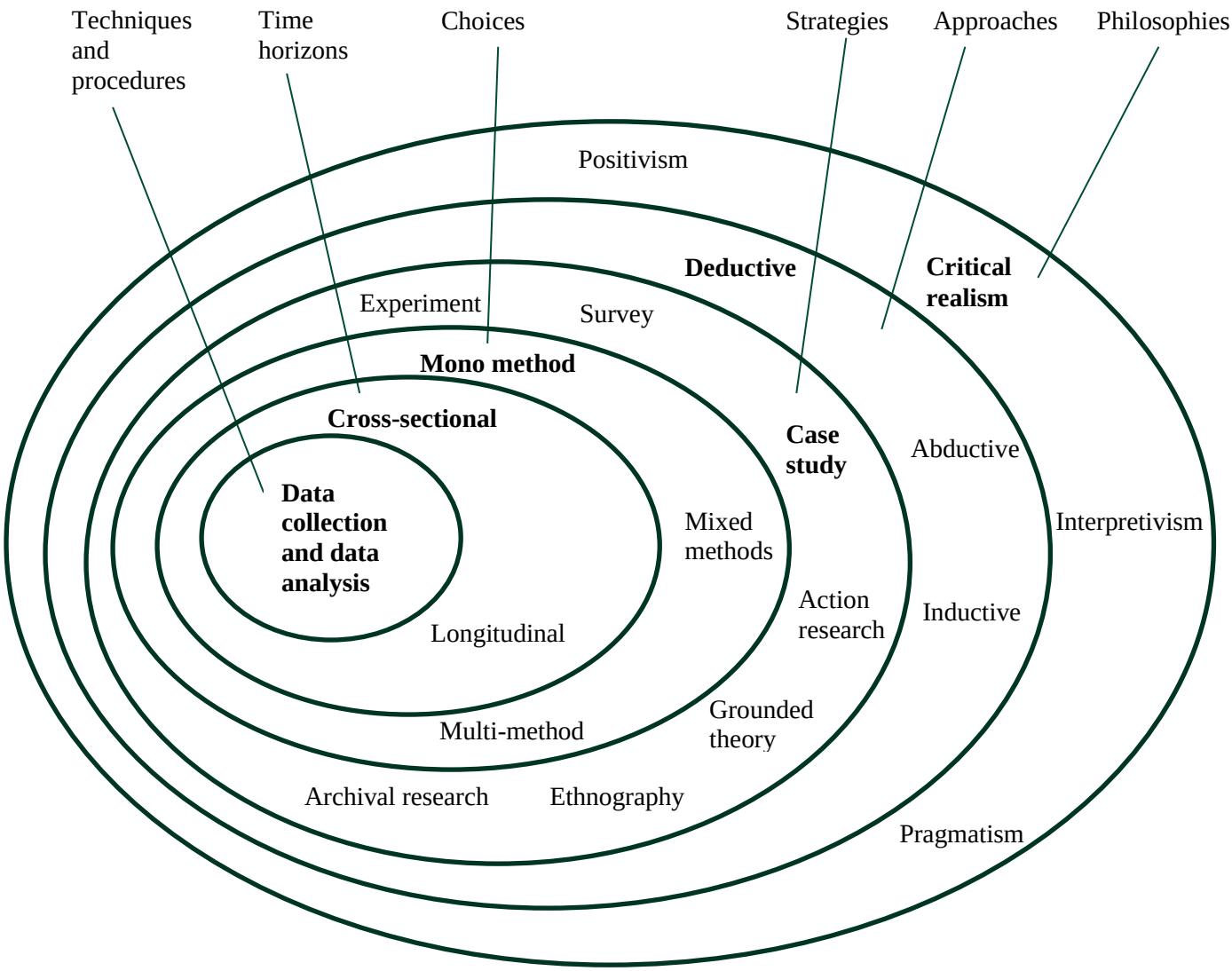

Figure 7. Methodological decisions shown in research onion (adapted from Saunders et al. 2009, p. 108)

According Saunders et al. (2009) the philosophy of critical realism focuses on explaining what we see and experience, in terms of the underlying structures of reality that shape the observable events. Critical realists see reality as external and independent, but not directly accessible through our observation and knowledge of it. Critical realism claims there are two steps to understanding the

world. There are the sensations and events we experience and there is the mental processing that goes on sometime after the experience, when we 'reason backwards' from our experiences to the underlying reality that might have caused them. (Saunders et al., 2009). Target in this study is to investigate how things are, what is being said about the phenomenon, and what aspects are associated with the phenomenon under consideration. In other words, through interviewing people will find out what people think, what values they have and what experiences they have. Therefore, critical realism is well-suited philosophy for this thesis.

The research approach used in this thesis is inductive, which is typically in qualitative research. The aim is to develop theory from the results of data analysis. The inductive approach allows changes in research priorities as the research progresses, ie it has a flexible structure. (Saunders et al., 2009).

The strategy of this thesis is case study from which are more details in chapter 3.1. The data is collected using mono method and contained the semi-structured interviews from the selected people in three different case companies. Choosing the mono method, the researcher use a single data collection technique, qualitative or quantitative and combines it with the analysis technique (Saunders et al., 2009).

The time horizon of this thesis is cross-sectional, which focuses on a particular phenomenon at a selected time, therefore it gives a snapshot of situation. (Saunders et al., 2009). The aim is to find out how the phenomenon, in this case Big data, affects a particular social and cultural environment at the time of the study. The master's thesis research project is generally time-limited, therefore the longitudinal time horizon is not applicable here. Therefore the cross-sectional time horizon is suitable in this thesis.

Information on the study was collected from the literature, which mainly focused on research articles and earlier studies. The empirical part was carried out through interviews, the results of which were analyzed by a qualitative method. The results of the study were also examined from the point of view of reliability and validity. Reliability and validity are discussed in more detail in the next section 3.3. They are also discussed in section 6.2, which evaluates the success of the study.

3.3 Reliability and validity

Reliability refers to the reliability of information obtained from research. Validity, in turn, means that there has been an investigation of the very issue that was to be investigated. They are indicators of the credibility of scientific research.

Reliability is concerned with the question of whether the researcher is obtaining data on which she or he can rely. (McKinnon 1988, 36). Reliability can be impaired if the data are not independent of the accidental circumstances under which they were gathered (Kirk and Miller 1986, 20). A general limitation and threat to the reliability of a case study is the search for empirical evidence in support of a built theoretical theory. Therefore, in principle, this qualitative study is not necessarily intended to reinforce literary hypotheses, but rather to test them in a practical environment.

The validity assessment determines whether the researcher has investigated the specific phenomenon that was to be investigated. The validity of a study is impaired if too much or too little attention is paid to a phenomenon other than the one being studied in the design or implementation of the study. (McKinnon 1988, 36).

McKinnon (1988, 37) presents in his study the four main types of validity and reliability threats: 1) observer-caused effects, 2) observer bias, 3) data access limitations and 4) complexities and limitations of the human mind. Observer-caused effects can occur if the researcher's role is such that it changes the participants otherwise natural behavior. Observer bias can enter, if the observer’s presence actually changes the phenomenon under study. It can enter all of the three stages of registering, interpreting and recording events (Scwartz and Swartz 1955, 91).

There may occur data access limitations, if the researcher is only on site for a limited period of time and cannot observe what happened before and after or if researcher is not in a position to observe the historical background of the phenomenon. The complexity and limitations of

the human mind mean that statements may not be taken literally. The subject may deliberately try to weaken or mislead the research, or the subject may try to be honest and accurate, but his or her statements and reports are affected by natural human tendencies and mistakes. (McKinnon 1988, 37-39).

In the study, the interviewees were interviewed individually so that they could concentrate on their own knowledge without external influences and stimuli. The interviewees were given questions in advance, but further questions were asked during the interview to ensure understanding. Reliability can be affected by the fact that interviewees work in positions that handle confidential information. Another issue that may affect reliability is that the interviewer does not work for the company and is seen as an outside person, therefore the interviewees think more closely about what they can say. Big data is a significant competitive factor for companies, so you may not want to go into too much detail about it.

4 Case machine engineering companies

4.1 Case introduction

This section introduces the companies involved in the case and reviews the interview responses by topic. The answers can be found as direct quotations and have also been partially analyzed already in this chapter.

Three industrial companies Valmet, Metso and Cargotec/Kalmar were included in the research. Controllers, development managers and application managers of these companies were interviewed. They work in different business areas within the company, so the interviews provided a comprehensive description of the views of each company.

The following is a brief description of all three companies.

Valmet is the leading global developer and supplier of technologies, automation and services for the pulp, paper and energy industries. Valmet's vision is to become the global champion in serving its customers. There are 13,000 professionals around the world work close to their customers, and are committed to moving customers' performance forward. (www.valmet.com)

Valmet's services cover everything from maintenance outsourcing to mill and plant improvements and spare parts. The strong technology offering includes pulp mills, tissue, board and paper production lines, as well as power plants for bio-energy production. Valmet's advanced automation solutions range from single measurements to mill wide turnkey automation projects. The company has over 200 years of industrial history and was reborn through the demerger of the pulp, paper and power businesses from Metso Group in December 2013. Valmet's net sales in 2018 were approximately EUR 3.3 billion. Valmet's head office is in Espoo, Finland and its shares are listed on the Nasdaq Helsinki. (www.valmet.com)

Metso is a world-leading industrial company offering equipment and services for the sustainable processing and flow of natural resources in the mining, aggregates, recycling and process industries. With their unique knowledge and innovative solutions, they help customers improve their operational efficiency, reduce risks and increase profitability. Metso employs over 15,000 people in more than 50 countries.

Company's ambition is to become one of the digital leaders in the industries it serves. They have Digital Program to create solutions to industry challenges, and their experts will continue to work with their customers and distributors to fully embrace the opportunities of digitalization. (www.metso.com)

Cargotec is a leading provider of cargo and load handling solutions with the goal of becoming the leader in intelligent cargo handling. Cargotec's business areas Kalmar, Hiab and MacGregor offer products and services that ensure their customers a continuous, reliable and sustainable performance. Cargotec's aim is to transform from an equipment provider into a leader in intelligent cargo handling. It will achieves this by focusing on its four strategic must-win battles: customer centricity, services, digitalisation and productivity. (www.cargotec.com)

Kalmar's offering comprises industry shaping, sustainable cargo handling equipment and automated terminal solutions, software and services. These are used in ports, terminals, distribution centres and various industries. Kalmar provides straddle and shuttle carriers, terminal tractors, yard cranes, ship-to-shore cranes, reachstackers, empty container handlers and forklift trucks. Navis terminal operating systems (TOS) and Bromma spreaders are provided as part of the Kalmar business area. (www.cargotec.com/fi/kalmar)

4.2 Big data utilization in the companies

At the beginning of the interview, the interviewees were asked what the big data meant, and also how they understood it in their company. The answers were quite similar. The definition was pragmatic and turned to the interviewee's own activities. The existence of big data was recognized and understood what it meant.

> "*From my point of view, this means large amounts of data that traditional softwares such as ERP cannot handle, but require a dedicated data warehouse solution. It is not enough to bring information into one repository, but to keep the model in a logical way that can be utilized. Often, gathering information from multiple locations to one place focuses on internal data, but this could be done for external data as well, and take advantage of its related functions*." Director, Business Reporting Development, Valmet

> "*Big data is a huge mass of data that does nothing as such, but processing provides useful information for different areas of the business."*
> Controller, Valmet Mill

> "*Big data means huge masses of data, out of hundreds of millions of event bits, e.g. device metrics such as exhaust emissions. We are talking about big data with the term unstructured data, compared to the older, more traditional data. Big data is considered very important in our company, especially in the business side*." - Manager, HFM Application, Metso

> *Big data refers to data from multiple data sources and requires a sophisticated data modeling program to read it. There is something hard to find with standard spreadsheet programs. It requires some tool to understand it."*
> Controller, Cargotec, Kalmar

Interviewees understood the importance of big data and the value it provides. They felt that their companies are not utilizing much of big data. However, everyone was interested in the subject and they thought that it would be useful to make the most of it. Some of the interviewees say, that for some years now, there has been a clear trend towards increased use of big data. Still, their data processing capabilities are not matched to what Big data implementation to would require.

The biggest single reason for low utilization was the lack of systems. This issue was well recognized, and companies worked to improve it. For example, Valmet had set up a unit headed by an expert in finance and systems development. The idea is to develop a system that serves the business economy as much as possible. Individuals with an IT background are unable to take economic issues into account.

> "*I would see that all companies should consider it important that this data has been in the company for a long time. The problem has been that it has been drowned in the source systems. Whatever the function or type of business, in my opinion, that relevant data should be easily accessible to end users so that it can then guide business, create forecasts and create strategic goals, etc*." – Director, Business reporting development, Valmet

> "*It means handling large amounts of data. We have large projects with transactions that are tracked on a project-by-project basis. However, we do not speak about Big data in our organization, but we have a Data analytics team that works with Big data and does various analyzes*". – Controller, Valmet Capital business

> "*We are taking the first steps in big data exploitation, still the most of our decision-making is based on consolidated data. However, we think we would need more details. This scenario is challenging as there are gaps between big data and consolidated data, which require significant controller resources to explain on a monthly basis."* – VP, Aggregates Business Area, Metso

> "*We are at the very beginning of this path. It requires all systems to talk to each other. One common ERP is a really important starting point. We have multiple ERPs in use, which poses the challenge of having to compile and combine information somewhere else. Only then can we see it."* – Controller, Cargotec, Kalmar

Some of the interviewees were interested in knowing how Big data is defined in the literature. As mentioned in the literature review of this study, there does not have a shared and unambiguous definition to the term big data. Often uses a definition that includes three V, which refers to words volume, velocity and variety. This was presented also to the interviewees, and some of them use this definition to think about their own business with Big data.

> "*The nature of our business is not so fast-paced in this machine building service operation, speed is not the hallmark here. We are pretty early on, according to my observations*. – Controller, Valmet Mill

The interviewees were also asked about the situation of their company in relation to Big data usage, ie what area, functions or activities they use or plan to use Big data.

> *In this part of the business controller, in practice, this data you are dealing with is, related to, for example, sales volumes, new business flow, billing, order bookings and CR system information. In principle, quite a lot of information observations related to sales document data. On the Operational Controller side, we go more to operational data and information."* – Controller, Valmet Mill

"We have used our own information and databases in the financial function. We have one central database, Automation datawarehouse, to which we have collected information from various sources. There is currently a great deal of investment in the exploitation and analysis of data, also from an economic point of view. The ERP project and the projects around it are renewed, and the key is to really use that data." – Controller, Valmet Automation business

"*Our upcoming new systems will be harmonized across all units globally, and will be better able to handle large volumes of transactions across the organization. In the future, we will also have a BI tool that will link to other systems, making it even easier to exploit the information*." – Controller, Valmet Capital business

"Concrete examples can be found on the service side, data is imported for the needs of the maintenance business. Some tests and experiments are ongoing. In some of our businesses, we have also purchased services that include big data related functions." - Manager, HFM application, Metso

"*We have had a system where we can look directly at the profitability of equipment. It is made up of several sources of information. It is now at the point where it is being used all the time. We have overcome the most difficult phase of modeling and that is the process and now people are starting to want data*." - Controller at Kalmar

Valmet's Business reporting development function is responsible for developing reporting and data warehousing globally. This includes cubes and tabular models that are produced for the end user. In addition, dashboards and other tools are used for analyzing data. Their work is guided by strategic goals that prioritize every six months what action to take next.

> "*The goal is that relevant data should be easily accessible to end-users to guide business, generate forecasts, and create strategic goals. The things that are considered Big data must be well defined and limited so that information will not gush, otherwise it is difficult for the decision maker to get the substantive information. The better the information we have and the more real-time it is, the better you can evaluate the current state and make changes. And keep in mind that too much can be too much.*" – Director Business reporting development, Valmet

Challenge related to system reform was that, at the same time as the development of a new repository, other system projects are underway, which are unstable and cause special phenomenon on the database side. Another challenge is the fact that users are not yet able to follow new processes. Due to these issues, the repository definitions need to be constantly iteratively modified.

One of the challenges is to build global solution for a large group, that get global definitions and production. It was considered important that the solution is truly global and the same between different countries and units.

According to the interviewees at Metso, in some processes it's still quite manual, there are manual checks and data correction. One their challenge is background information, someone talking about master data, someone else talking about metadata, and there are also differences in material titles and cost listings, which cause quality problems.

> "*Managing data related control is challenging because different terms are spoken by different parties. This is directly reflected in the quality of the data. We still have relatively few centralized repositories, although we are in a better position than many others, but we are not in the best position.*" – Manager, HFM application, Metso

4.3. Controllers' role in the organisation

The other major part of the interviews, was about the role of the controller and the main tasks, goals and challenges. Interviewees were also asked how their role has changed or will change with Big data.

Valmet has centralized financial management; the financial service center, which offers accounting, sales accounts, accounts payable and payroll services for the company. Business controllers are still working in the business units.

> "*The role of business controllers is to support management. Controllers are responsible for executive reporting such as monthly reporting, budgeting and forecasting. Controllers also perform the necessary analyzes for management use."* – Controller, Valmet Capital business

> "*In the big picture, I would define the role of a business controller as producing and analyzing financial information to support management people within my sphere of influence. The task is to produce information according to a certain formula. Over the years, processes have been created and we follow them. The development work is done as much as it has time*." – Controller, Valmet Mill

> "*The controller's most important task is to generate information to support management decision-making. Controllers work to promote business and increase transparency*." – Controller, Valmet Automation business

Valmet's Business reporting development organisation's the most important task is to develop reporting and analytics/BI. The second aspect is planning development. The Reporting development organization aims to develop easy-to-use and as automated reporting as possible. The goal is that there are no manual steps in between and the end to end reporting pipeline is automated. Also on the planning side, the end user will have to provide as little input as possible to create a financial plan.

> "*On the reporting side, it is very important to develop a single global repository for modeling data from source systems and making the information readily available to the business. That is, the ability to use self-service applications designed to be end-user friendly*." – Director, Business reporting development, Valmet

> "*The information comes from the source systems based on the master data and facts and undergoes some customization, which should then be done. That is, we use the trends found in the data, build drivers, parameters, and create different scenarios."*
> - Director, Business reporting development, Valmet

According to Business reporting organisation, it is also important to launch very well new tools into the organisation. Until now, there have used to report directly from ERPs, like listed data from Excel to pivot. It is important also to launch a new way of thinking about these issues.

> "*We also have such a sparring role in developing these things because our team has the expertise in new technologies. I see that we are in-house consultants and we also intend to spar our requirements to the next level by taking all the necessary data out of the available data*." – Director, Business reporting development, Valmet

Business reporting development director says that all reporting and related developments are driven by business needs. Interaction with different units must be strong. Their organization makes long-term plans and proposes reporting solutions, but needs to become a business entity. Their team has strong source system expertise but is not an IT organization, therefore IT support is needed elsewhere.

Metso employs approximately 300 people, either in the role of controller or in a position close to it. According Metso's HFM application manager, the tasks of the controllers have not yet changed much, but there is a strong belief that things will change in the coming years. The company is in the process of implementing information automation projects that will also affect the controller's role.

> "*Something has already started, eg. Internal Audit has initiated percentage analysis measures, including analysis of purchase invoices. One of my task is to maintain and support a reporting system that collects external financial data. It is important that the system meets the goals that we have set for them. My task is also to spar the controller-community where possible and make sure the smooth reporting process for them.*" - Manager, HFM Application, Metso

Kalmar has financial center, where are working all persons who takes care of financial accounting. Business controllers and business partners are still in the business units. The product lines and divisions also have their own controllers. In addition, each operational manager has his or her own business partner who supports with financial information.

> "*The Controller's most important role is to support the CFO in his role and to push forward the set goals. A role is a supporting role that advances projects that are not under the control of an individual division or market. There are also things that cannot be delegated to a single area but considered as a whole*." – Controller, Cargotec Kalmar

4.3.1 Challenges of controller work

Continuous rush is seen as a challenge for the controller, leaving little time for development. There are certain schedules for reporting, but for the rest, the work is perceived to be largely ad-hoc style and needs typically come from a wide range of people and from a variety of sources. Due to the urgency, it is felt that there is not enough time for analysis, and a change was desired. Interviewees believed that this issue would improve with system development, with more automation of workflows and better opportunities for analytics and data integration.

> *"In my opinion, data processing is not the challenge, but the challenge is with IT infra and how to model the data in such a way that it can be processed by the end user. This also involves the quality of the data and the master data. If not properly managed, there will be errors or poor quality material." – Director, Business reporting development, Valmet*

> *"Increasing data volumes puts pressure on the controller's role to be more capable with applications and able to handle larger amounts of data.*
> *Data processing is still largely influenced by the individual's ability to use various programs and ability to process data". – Manager, HFM Application, Metso*

Interviews were also mentioned the rapid changes, which also needs rapid response and this was seen as a challenge. One of the interviewees said that there is always a slight delay with development work on Big data and analytics before it is completed, and when the plan is ready, then there will be a new need that will affect the current plan.

One of the interviewees experienced that the challenges were more related to the organization and people. According to him, not every business has enough business-oriented people, so they do not understand the added value of reporting and analytics and may not give the controller work space and value. One of the interviewees said that they would need more ownership of financial tasks. It would make their role easier. Another option would be for organizations to better understand the functions of the economy. This is seen to have improved recently, but there is still room for improvement.

4.3.2 Decision making process

The interviewees were asked to describe the strategic decision-making process in the company. They were also asked whether controllers are involved in making decisions or producing information to support decision making. The question was also how the interviewees felt that the decision-making process could be improved.

All interviewees have the same opinion that strategic decisions were made at top management level.

> "*Controller always supports and analyzes as needed, but decision-making itself is made by top management. Controller is more of a producer of material and a reporter of background*." – Controller, Cargotec Kalmar

However, at Valmet company, business controllers were seen to be heavily involved, but also depending on the business area and management how much involved the controllers are.
Although the role of controller is to produce reports and analyzes for supporting decision-making, the interviewees considered it very important to be spontaneous that if you know of a challenge or area for improvement, you can make analyses and propose solutions.

> *"Business Controllers are strongly involved in the decision-making process by supporting analysis and reporting. On the basis of these, it is considered how to achieve the strategic goals. You can also bring out your own views, and I think it is important to give them views and feedback. However, the final decision is always with the business manager, but communication is really important and the controller must have the courage to give his or her views*." – Controller, Valmet capital business

Some of the interviews also highlighted that the role of the controller is not only to provide information but also to provide advice and training on how to use the data effectively.

At Metso company, strategic decision-making is based on both qualitative and quantitative assessments. Controllers provide detailed analysis of orders, sales and profitability, as well as inventory analytics and SGA tracking. Finance Business partner at Metso's customer logistics described the controller's role in the decision making process so, that one controller can be transactional controller with focus on analyzing granular data while other business controller can work with macrotrends and consider much more data sources decision making. The difference is that typically the business controller roles are part of business area or business line management teams with greater responsibility and involvement to decisions.

> "*A controller cannot be a mere producer of information. The role of the Controller is to research, make observations and sell ideas to management. Controller is a critical part of management decision making*."
> VP, Aggregates Business Area, Metso

Interviewees believe that utilizing new tools and processes will leave more time for analysis in the future. The interviewee, who worked in the reporting development function, argued that the controller's role would be changing and that controller should also be involved in decision-making as an economic expert.

> "*Whether or not a controller is involved in making decisions depends a lot on the controller's role in the organization. In fact, I was a controller at some positions only as a producer of information that is collected and data analyzes built, the basis of which management decisions are made. I have also been in the role in which I was a member of the management team and I made a decision and I interpreted the related data."* – Director, Business reporting development, Valmet

According to the interviewees, in the future, controllers want to be involved in the decision-making process. In their view, change is happening, but it is slow.

> *"So far, we have mainly produced historical data that looks at what has happened, what has affected it and what the changes are. The most important thing is to look to the future and this requires time to study things and to study them analytically. This will help us influence the continuity of the business and how we achieve our goals."* – Controller, Cargotec Kalmar

4.4 Big data utilization and its effects on the controller role

According to interviewees, Big data will change the role of the controller, for example, by focusing more on the customer and what will happen in the future. Some interviewees say, that they are now living through a breakthrough and there already are some controllers that are increasingly relying on big data, that is, fine-grained data found in the systems.

> "*Looking to the future means understanding what the customer really wants and how our business looks in the light of it. By utilizing Big data, we are able to see larger entities through small details. We are able to refine our operations and offers, among other things, when we know the customer's needs in greater detail*." – Controller, Cargotec Kalmar

One view was also that change may not even be noticeable so much, as many changes have taken place in recent years and even decades, but little by little, not by a one-time surge.

> "*If we consider that big data is something related to financial transaction, such as individual saler order line, big data has been there since 70s and controller role has changed only through the tools what we use to analyze data. In the 80s had to deliver full package of information whether it was handmade on paper, printed or through a computer file. Nowadays we talk about databases and various analytics tools which enable controllers to become more specialized to IT skills or be just general end user of analytics and other tools*." – Finance business partner, Customer Logicstics, Metso

It is believed that the role will become more automated with new systems and utilization of Big data, thus reducing manual work. The interviewers hoped that there would be more time for analysis in the future. They believe that new systems and processes will provide better and wider opportunities.

> "*New systems and processes give us a completely different way of analyzing data, as systems get different kinds of data together and don't have to go to dig separately*." – Controller at Valmet Capital business

> "*Manual work will be reduced, leaving more time to support management and business."* – Controller, Valmet Automation

According to the interviewees, automated tools need to be also user-friendly that some of the responsibility can be transfered directly into business units. This would allow the units to do some tasks independently, without the controllers having to separately compile reports for them.

> "*We are able to build the bases where certain things are ready and on a daily basis, that is, information is easier to access, so the controller focuses more on analysis and development. This will change the nature of work a lot. In the future, we will be able to handle certain issues globally and to concentrate some operations*." – Controller, Valmet Capital business

> "*When it comes to internal clients, the controller strives to work towards making information easily accessible and usable, that is, made available in a user-friendly way. Today, various tools allow graphical presentations to be made and individuals can view information directly from programs in a presentation format*." – Controller, Valmet Mill business

Interviews were also mentioned, that in a phase of change as new tools are introduced and big data becomes more utilized, the controller's role is to act as a facilitator of business monitoring needs, and also support testing and involve to the development of tools.

> "*Comprehensive controllers are needed and appreciated, that is, that they master all the essential substance issues and that the concepts are clear and that which things control them and what is included in them. You also have to be IT-friendly and at the same time be interested in your business. There is an enormous amount of information available, requiring the ability to distinguish essential information from everything*." – Controller at Valmet Mill business

> "*The tasks have not yet changed much, but there is a strong belief that things will change in the coming years. The goal is to pay attention to more automation of data between systems and more economic use of such automation*."
> Manager, HFM application, Metso

> "*The future controller first and foremost has to evaluate the future and understand what business is driving. The role of the Controller is to look at the financials to determine what is relevant to the business and how it can guide the organization in the right direction*." – Controller, Cargotec Kalmar

According to the interviewees, the role of the controller will change enormously in the future due to data and digitalisation. However, the roles are gradually changing and some are adopting new tools faster, while others are looking at the situation first. Some of the interviewees stated that companies are moving at different speeds in the flow of change, but digitalization will shape the role of controllers in general in any case.

5 Discussion

The purpose of this study is to investigate the effects of big data on the role of controller. The study examines how companies use big data and whether its use has effected the role of controller. Also, the decision-making process and the role of controller on it are explored. Is the controller a producer of information or is he involved in decision-making. In this chapter, the empirical results are reflected against the main findings of the literature review.

5.1 Big data utilization in the companies

All responses from interviewees were similar when asked big data meaning in general. It is an huge amount of data which can produce important benefits for different areas of the organization by refining and utilizing. Big data is compared to structured data and perceived to be a large amount of unstructured data. McGahan (2013) describes that big data is too large to handle with conventional software programs such as Excel, therefore this requires special analytics.Sun et al. (2015) argued that big data is data whose sources are heterogeneous and autonomous; whose dimensions are diverse, whose size beyond the capacity of conventional processes or tools to effectively and affordably capture, store, manage, analyze and exploit, and its relationships are complex, dynamic and evolving. (Dubey, 2016).

Most of the interviewees felt that their company was still in the early stages of actually utilizing big data. However, all companies have taken steps to understand big data and understand its potential and benefits. Everyone perceived that big data is important to their company, especially in the business side of the organisation, and it has been a trend for several years that big data will be used more and more. Also Vasarhelyi et al. (2015) see that although changes in accounting practices and standards in response to big data have yet to happen, big data has the potential to cause a paradigm shift allowing economic activities to be traced and measured earlier and deeper. (Vasarhelyi et al., 2015).

The biggest single reason for low utilization is the lack of systems. It requires all systems to talk to each other. This seems to be common factor in every companies, and each of them is working to develop their systems so that they can be better utilized in the future.

Other challenge is that when there is development project with a new repository, other system projects are underway, which are unstable and cause special phenomena on the database side. Also, different terms cause challenges, because there is directly reflection in the quality of data, if there are differences in material titles and cost listing.

Vasarhelyi et al. (2015) Practical application of the expansion of accounting data sets may include the ability to process and analyze more detailed data, to integrate into analysis a variety of both internal and external data, to do "soft integration" of environmental big data (e.g. social networks and new parts) with accounting measurement and audit assurance processes and the ability to transform accounting, business and audit process based on all of these. (Vasarhelyi et al, 2015).

Companies feel that much more detailed and up-to-date data would be needed. The better the information they have and the more real time it is, the better they can evaluate the current state and make changes. However, for the moment they feel that there are gaps between big data and consolidated data, which require significant controller resources to explain on a monthly basis.

One important target of developing data process and data utilization is that data should be easily accessible to end users so that it can then guide e.g. business, create forecasts and create strategic goals. They are able to build the bases where certain things are ready, they are on a daily basis, and information is easier to access. In this way controllers can focus more on analysis and development. According interviewees this will change the nature of work a lot.

5.2. Controllers' role in the organisation

De Loo et all (2011) stated that some research see that management accounting profession and roles are changing from beancounter stereotype to business advocate. Business advocate supports and advise senior managers in strategic decision making. There also is argued hybrid management accountants, who have both bean counting and business advocate type of activities. Caicedo, Mårtensson & Tamm Hallström (2017) argued that the role of management accounting has been developed, so that it is widened from focusing on operational issues to a wider scope of responsibility that includes participation in decision-making. They called that kind of role as a business partner.

Grandlund and Lukka (1998) stated that there is need for management accountants to move away from the roles of business historians and company watchdog towards more commercially oriented functioning. In the new role, management accountants operate like true members of management teams and are able to act as change agents in organizations.

Graham (2009) has investigated that management accounting role had moved from the old-fashioned 'corpore cop' into the business partner whose task is to add value to the business. They should be the part of management team, where they can support strategy and drive change.

The interviewees also felt that the controller is not only a producer of information, but that his/her role is to support management in decision-making. According them, controller are responsible for executive reporting and perform the necessary analyses for management use. Controllers work to promote business and increase transparency.

Byrne and Pierce (2007) has developed a model where antecedents and characteristics of individuals and activities affected on the roles of management accountants. Authors mention that management accountants themselves have a considerable influence to their own roles. Accountants' attitudes, personalities and initiative were important issues on this development. Also, company affects on the roles too, e.g. company's size and is it subsidiary or independently owned.

The same view emerged in the interviews. There is a lot about the controller, how he or she learns new things and develops himself. Controller need to be IT friendly and at the same time be interested in the business. The role and responsibilities of a controller are also influenced by what kind is the company, how the management accountant is organized within the company and to which organizational unit the controller belongs. For example, in some cases, the controller has a strong role to play in supporting decision-making, while in some roles he is not involved at all in decision-making.

This comes up also in Sathe's (1983) research. He has created role categories for controllers to provide management a way of thinking about the roles and what kind of them could suit for the organisation. The involved controller is responsible for management-service. The independent controller's main tasks are financial reporting and internal control responsibilities. The split controller operates within an organization where financial reporting and management and service responsibilities are shared. The strong controller remains both major controller responsibilities and is actively involved in decision making process.

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5.3. Big data utilization and its effects on the controller role

Vasarhelyi et al. (2015) argue that big data changes fundamentally what we mean by information, for instance, organisations have the ability to provide real-time information, which is contrary to traditional accounting of summary and aggregation of information provided on period basis.

Real-time information and information obtained in more detail from different clients was also discussed in several interviews. This was believed to be one of the biggest benefits of using Big Data. In addition, real-time information also helps in forecasting. Big data can be used to predict the future, which will bring significant business benefits. According to the interviewees, for the time being, prediction is still done by mirroring past periods.

Warren et al. (2015) stated in their study that big data will significantly change accounting in all aspects of practices and the profession. There will be improved for financial accounting quality and relevance of accounting information, thus transparency and stakeholder decision making. Also for corporate reporting the creation and refinement of standards will be aided ensuring the profession's continuous evolution in unison with the real-time economy (Warren et al., 2015).

Improvements and speeding up the processes were also mentioned in the interviews. With process automation and Big data utilization, information is faster, smoother, and more accurate. In addition, information can be generated from the systems directly for use in different business areas without the controller having to intervene as a reporting agent. This also changes the role of controller and leaves more time for analysis and further work. Several interviews wished more time for developing their own activities.

Hodginson and Gillon (2012) argue that the growth of big data together with increased processing power, sophisticated algorithms and advanced statistical methods suggest that there should be many opportunities to improve management reporting and understand the connections between financial and non-financial measures. (Hodginson and Gillon, 2012).

Interviewees also noted that digitization has been going on for years, therefore the changes brought by Big data will not come as an unexpected or sudden process. In recent years, there have been changes in several business areas, including streamlining operations and processes. However, the exploitation of Big data requires the development of systems and the integration of functions, which means that the potential of Big data is not yet available within the company. However, for instance, outsourced services can already provide some of the benefits of Big data to the companies.

6. Conclusion

This section concludes the results of the thesis and presents its contributions. The first paragraph describes the people interviewed, the interview questions and the main findings. The second paragraph evaluates the success of the research and the third section discusses how the results can be used in the future and what could be the subject of further research.

6.1 Analysis of results and main findings

The purpose of the thesis was to investigate how company utilize Big data in their operations and how it has been affected to controllers' roles. The empirical part of the thesis base on a qualitative case study and the question is studied in three machine engineering companies by interviewing experts. The interviewees were from Valmet, Metso and Cargotec.

There were total four persons from Valmet company. Three controllers, who each working in a different business area and one person, who is responsible for unit of report developing. The interviews provided good and comprehensive answers, because the controllers were well aware of the tasks of controller and were also able to answer questions on these topics, reflecting on the past and the future. The interviewee from the Reporting Development Unit, knew well the situation of the company regarding reporting development and related systems. Metso had three interviewees, two of whom work in financial management and one in systems management. Cargotec had one interviewee, who works as a controller in Kalmar, one business area in the company. Also, the interviewees at Metso and Cargotec were well aware of the controller's responsibilities and were sufficiently knowledgeable about the situation of their company in matters related to Big data usage.

The main research question is *How Big data utilization affects the controller's role.*
In order to provide the necessary overview of the company's situation with regard to the use of Big data, general questions were asked at the beginning of the interview, such as *what does Big data mean to the interviewee, how the term is understood in the company and what areas it is currently used*.

One common finding was that Big data is still not being used much in companies. The importance and potential of Big data is well understood and the company wants to increase the utilization of Big data in the near future. There has been a clear trend towards increased use of Big data, but still their computing capabilities are not matched to what Big data implementation would require. That is, the reason for the low utilization is mainly the lack of systems.

Findings on the main research question of the thesis, how Big data utilization affects the controller's role, were that utilization of Big data would make controllers focus more on the future than reporting on past periods. The information will be more customer-specific, up-to-date and faster, which affects the content of the reporting. All interviewees believed that with Big data, the controllers' tasks will become more automated, reducing manual work. This is expected to give more time to focus on the future and to conduct future analyzes. Automation was thought to give controllers more time to develop their tasks, which was also expected.

New systems and processes are believed to provide better and wider opportunities to develop the role. As one example, the process development can provide information directly to units, so that the controller no longer has to be involved in producing this information. The changes are believed to take place gradually, so the exploitation of Big data, as well as the benefits and changes in functions and roles, will not come as a sudden event.

One examination object in this study is also *strategic decision making and controller role in this process*. The issue was investigated by asking interviewees about the organization's decision-making process and the role of controller in this process. The questions followed the frame of reference obtained from the theory.

The interviews asked the experts' opinion whether the controller is rather a producer of information in the decision-making process or whether he is also involved in the decision-making. The finding is that strategic decisions are made at the top management level. All the respondents were of the same opinion. When discussed about decision making in the general or operational level, it varied slightly depending on the respondent. Interviews revealed that a person's personality greatly influenced responses when asked whether controllers are involved in decision-making. The majority felt that they were not directly involved in decision-making, while a few felt involved in decision-making and even challenged management if they disagreed with management. Those respondents who seemed to have good social skills and were confident in their own role also felt more involved in decision-making. Respondents who were more modest felt that they did not participate in the actual decision-making.

The finding was that the role of controller was considered very important in the decision-making process, whether it was to produce data or to participate in decision-making. According to the respondents, data producing is also combined with data analysing, ie the controller not only reports, but also analyzes the information and makes it a presentation to the management. Controllers also provide advice on how to use the data effectively. Controller is also seen as a researcher, who makes observations and sell ideas to management. Especially business controllers are strongly involved in the decision-making process supporting with reports and analyzes.

The future factor appeared in the interviews. The work of controller is strongly related to data produced on the basis of historical data, when the goal would be to move to utilizing information that reflects the future. This has a strong impact on business development and goal setting when more accurate forecasts and future plans can be made.

6.2. Evaluating the research

The literature section of the study delved into various studies dealing with big data, the various roles of the controller, the decision-making process, and the effects of using big data on the above. In the empirical section, the same issues were addressed by three engineering companies, from which controllers and other experts were interviewed.

The empirical findings of the study cannot be fully generalized, as responses were received from only three different companies. On the other hand, companies are operating in the same industry and responses are very similar regardless of company, suggesting that the orientation is at least similar in other similar companies.

The interviewees were very cooperative and shared as much information as they could; they also asked for more detailed information from their colleagues, if they didn't have answer by themselves. A limiting factor to reliability, however, was that the interviewees did not have in-depth knowledge of the big data, because they don't use it yet widely, so the responses were at a fairly general level. Some responses also revealed that interviewees did not distinguish between normal data and Big data.

The topics of the interview were broad and concerned both big data and business, but also the role of the person in the company, which is a more in-depth topic. This could make it difficult to answer and affect the quality of the interviews. One of the limiting factors in the interviews was that some of the information related to big data was confidential. For instance, one of the companies said they would buy some of the big data services, but couldn't give details because they didn't want to share the information with competitors.

According to the study, big data and its utilization are perceived as very important and every company worked with the tasks related to big data implementation. However, the use of big data was not yet very advanced in any company, but its utilization was very early phase and this has implications for the study's generalizability. And because of this situation, the controllers did not have an overall picture of how big data was used at the company level, but answers based on the situation in their own business area. On the other hand, the answers were very similar, regardless of the organizational area of the interviewee. The information obtained from the interviews was therefore comprehensive.

The limiting factor was that the interviewees did not have complete information about the stage at which big data projects were going on in their company. The exception to this was experts who worked on reporting development tasks, but neither were they able to estimate a precise timetable for development. As a result, the question remains as to when the next big step for companies to take advantage of big data is.

The effect of culture on the role of the controller could not be properly investigated in the case section because Big data is not utilized to the extent that it would affect culture.
Responses to the controller role change and the controller role in the decision-making process varied widely, depending on where in the organization the controller worked. There were considerable differences in roles within the same company. There was also some dispersion in recognizing role change, depending on the respondents, some saw that the role would not have changed and others saw it changing or changing in the future. This has an impact on generalizability. The reliability of the answers was considered very good as the interviewees were well aware of the controller's various tasks and roles in the organization and were thus able to answer comprehensively these questions.

6.3 Suggestion for future research

The thesis can be considered successful as the research provided a good understanding of the current state of Big data, and comprehensive answers to the questions were obtained. In addition to the interviews, it was interesting to examine issues raised in the literature review regarding Big data and the role of controller. The interview frame was entirely based on a literature review, which provided the researcher with both a theoretical and a practical overview of the research topic.

Big data is still being exploited at a very early stage by the companies involved in the study, so it would be interesting to investigate this again in a few years. According to the results of study, the benefits of Big data utilization were understood by the companies. All of the interviewees saw that the trend is to increase the usage of Big data.

Companies are working at the moment to develop their information systems, and one of their goals is to make Big data better available. Not only would it be interesting to look at the evolution of the situation in the next few years, there could also be further exploration of the areas where Big data has been made available.

The effect of culture on the role of controller could not be properly investigated in the case section because Big data is not utilized to the extent that it would affect culture. This would also be interesting research topic in the future.

This study focused on the role of financial management and the utilization of Big data, excluding the technical details and analytical sides. It would be interesting to investigate these as well, when Big data usage is more common in companies. This is more useful, and even possible, until Big data is up and running and can be analyzed and utilized across different businesses and regions of the companies.

References

Addo-Tenkorang, R. & Helo, P. (2016). Big data Applications in Operations/Supply-Chain Management: A Literature Review. Computers & Industrial Engineering. Vol. 101, pp. 528-543

Al-Htaybat, K. & Alberti-Alhtaybat, L. (2017). Big data and corporate reporting: impacts and paradoxes. Acccounting, Auditing & Accountability Journal, 30(4), pp. 850-873.

Amason, A. (1996). Distinguishing the effects of functional and dysfunctional conflict on stratewgic decision making: resolving a paradox for top management teams. Academy of Management Journal, 39(1), pp. 123-148.

Bantel, K.A. and Jackson, S.E. (1989). Top management and innovations in Banking: Does the composition of the top team make a difference? Strategic Management Journal, 10, pp. 107-124.

Bhimani, A. (2013). Strategic Finance: Achieving high corporate performance. Strategy Press. London.

Bhimani, A. & Willcocks, L.P. (2014). Digitisation, 'big data' and the transformation of accounting information. Accounting and Business Research, 44(4), pp. 469-490.

Brinch, M. (2017). Understanding the value of big data in supply chain management and its business processes: Towards a conceptual framework. International Journal of Operations and Production Management, 38, pp. 1589-1614.

Brinch, M., Stentoft, J., Jensen, J. & Rajkumar, C. (2018), Practitioners understanding of big data and its applications in supply chain management, International Journal of Logistics Management, The, 29(2), pp. 555-574.

Burns, J., & Vaivio, J. (2001). Management accounting change. Management Accounting Research, 12(4), 389-402.

Byrne, S. & Pierce, B. (2007). Towards a more comprehensive understanding of the roles of management accountants. European Accounting Review, 16(3), pp. 469-498.

Caicedo, M., Mårtensson, M. & Tamm Hallström, K. (2017). The development of the management accountant's role revisited: An example from the Swedish Social Insurance Agency. Financial Accountability & Management, pp. 1–12.

Chen, H. Chiang, R. & Storey, V. (2012). Business intelligence and analytics: from big data to big impact. MIS Quarterly, 36(4), pp. 1165-1188.

Child, J. & Keiser, A. 1981. " Development of organizations over time". Handbook of Organizational Design, Vol. 1, pp. 28-64.

De Loo, I., Verstegen, B. & Swagerman, D. (2011). Understanding the roles of management accountants. European Business Review, 23(3), pp. 287-313.

Dent, J. (1990). Strategy, organization and control: some possibilities for accounting research. Accounting, Organizations and Society, 15(1), 3-25.

Dubey, R. (2016). The impact of big data on world-class sustainable manufacturing. University of Plymouth, pp. 3-4.

Friedman, A. L. & Lyne, S.R. (2001). The beancounter stereotype: Towards a general modelof stereotype generation. Critical Perspective on Accounting, 12(4), 423-451.

Goretzki, Strauss & Weber (2013). An institutional perspective on the changes in management accountants' professional role. Management Accounting Review, 24, pp. 41-63.

Graham, A. (2009). The financial controller. Financial management, 4, pp. 32-33.

Granlund, M. & Lukka, K. (1998 a). It's a small world of management accounting practices. Journal of Management Accounting Research, 10, 153-179.

Grandlund, M. & Lukka, K. (1998 b). Towards increasing business orientation: Finnish management accountants in a changing cultural context. Management Accounting Research, 9(2), pp. 185-211.

Hirsjärvi, S. Remes, P. & Sajavaara, P. (2007). Tutki ja kirjoita. Kustannusosakeyhtiö Tammi. Helsinki.

Janssen, M., van der Voort, H. & Wahyudi, A. (2017). Factors influencing big data decision-making quality. Journal of Business Research, 2017, vol. 70, issue C, pp. 338-345.

Järvenpää, M. (2007). Making business partners: A case study on how management accounting culture was changed. European Accounting Review, Vol. 16(1), pp. 99-142.

Kirk, J., & Miller, M. L. (1986). Qualitative Research Methods: Reliability and validity in qualitative research. Newbury Park, CA: SAGE Publications

Lamba, K. & Singh, S. P. (2017). Big data in operations and supply chain management: current trends and future perspectives. The Management of Operations, Vol. 28, Issue 11, pp. 877-890.

Ministry of transport and communication in Finland (2014). Big datan hyödyntäminen. Liikenne ja viestintäministeriö, julkaisuja 20/2014.

McKinnon, J. (1988). Reliability and validity in field research: some strategies and tactics. Accounting, Auditing and Accountability, 1(1), 34-54.

Manyika, J., Chui, M., Brown, B., et al. (2011). Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute.

Mintzberg, H. (1978). Patterns in strategy formation. Management Science, Vol. 24(9), pp. 934-948.

Murray, A. (1989). Top management group heterogeneity and firm performance.Special issue: Strategic Management Journal: Special Issue, strategic leaders and leadership, 10(1), pp. 125-141.

Neumann, F. (2016). Antecedents and effects of emotions in strategic decision-making: a literature review and conceptual model. Management Review Q, 67, pp. 175-200.

Nielsen, E. H., Jacobsen, A. & Pedersen, L. B. (2014). Management accounting and business analytics. Danish Journal of Management & Business, 78(3-4), pp. 31-44.

Pickard, M. D. & Cokins, G. (2015). From bean counters to bean growers: accountants as data analysts – a customer profitability example. Journal of Information Systems, 29(3), 151-164.

Scapens, R. W. (1990). Researching management accounting practice: The role of case study methods. The British Accounting Review, 22(3), 259-281.

Saunders, M., Lewis, P.& Thornhill, A. (2009). Research methods for business students. Pearson Education. United Kingdom.

Sathe, V. (1983). The controller's role in management. Organizational dynamics, Vol. 11(3), pp. 31-48.

Seo, M-G. & Creed, W. (2002). Institutional Contradictions, Praxis, and Institutional Change: A Dialectical Perspective. The Academy of Management Review 27(2), p. 222

Vaivio, J. (2007). Qualitative research on management accounting: Achievements and potential. Pearson Education Limited: Issues in Management Accounting. Third edition, part 4, article 20, pp. 425-443.

Vaivio, J. (2008). Qualitative management accounting research: Rationale, pitfalls and potential. Qualitative Research in Accounting & Management, 5(1), pp. 64-86.

Vasarhelyi, M.A., Kogan, A. & Tuttle, B. M. (2015). Big data in accounting. An overview. Accounting Horizons, 29(2), pp. 381-396.

Warren J., Moffitt, K. & Byrnes, P. (2015). How big data will change accountig. Accounting Horizons, 29(2), pp. 397-407.

Websites:
General information of the case companies Valmet, Metso and Cargotec/Kalmar
www.valmet.fi
www.metso.fi
www.cargotec.fi
www.cargotec.com/fi/kalmar/

Appendices

Appendix 1

Interview questions for controllers:

Big data

- What do you think Big data means / how is this term understood in your company?
- How important do you think Big data is to your business?
- In what areas do you use it?

Controllers' tasks/role

- How are the responsibilities of the controllers distributed within your company (centralized financial management or function / unit)?
- What are your main tasks and goals in your organization?
- What kind of the challenges are in the controller tasks?
- What kind of information does the controller need in his/her work on the various functions of the organization?
- How have tasks/roles changed with Big data?
- How do you see the controller role evolving in the future?

Decision making process

- How would you describe the strategic decision-making process in your organization / unit?
- What kind of role controller is in the decision-making process?
  (involved in making decisions or the producer of the material)
- What kind of information does the controller provide to support the decision-making process?
- In what ways do you think the decision-making process could be improved from the controller's point of view?

Appendix 2

Interview questions for other roles than controller:

Big data

- What do you think Big data means / how is this term understood in your company?
- How important do you think Big data is to your business?
- In what areas do you use it?

Tasks and role

- What are your main tasks and goals in your business unit?
- What kind of information do you need in your work about the various functions of the organization (with whom do you mainly collaborate within the company regarding information production and processing)?
- What are the challenges in producing and processing information?
- How have tasks changed with Big data and how do you see them evolving in the future?

Decision making process

- How would you describe the strategic decision-making process in your company?
- What kind of role you and your unit are in the decision-making process? (involved in making decisions or producing information)
- What kind of information do you provide to support the decision-making process?
- How do you think the decision-making process could be improved from the perspective of your unit?

Controllers' tasks/role

- What kind of role your company's controllers are in producing and processing Big data related information?
- Do you think the role of controllers has changed in recent years with Big data?
- How are controllers involved in the decision-making process? (involved in making decisions or producing information)